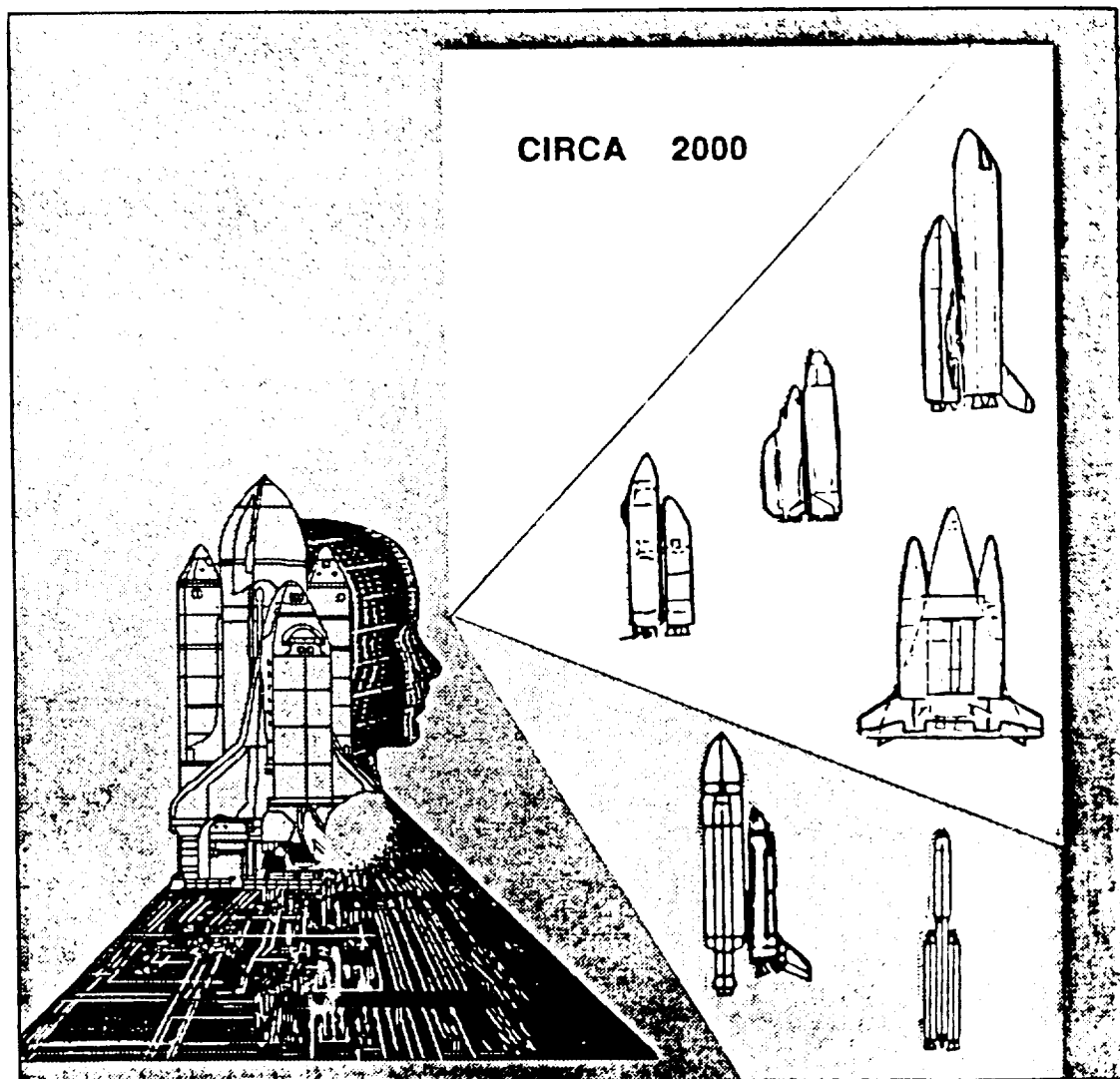


BOEING

Shuttle Ground Operations Efficiencies/Technologies Study

AEROSPACE OPERATIONS



FINAL REPORT PHASE 3

Volume 4 of 4

51-L WORK VOLUME INDICATORS

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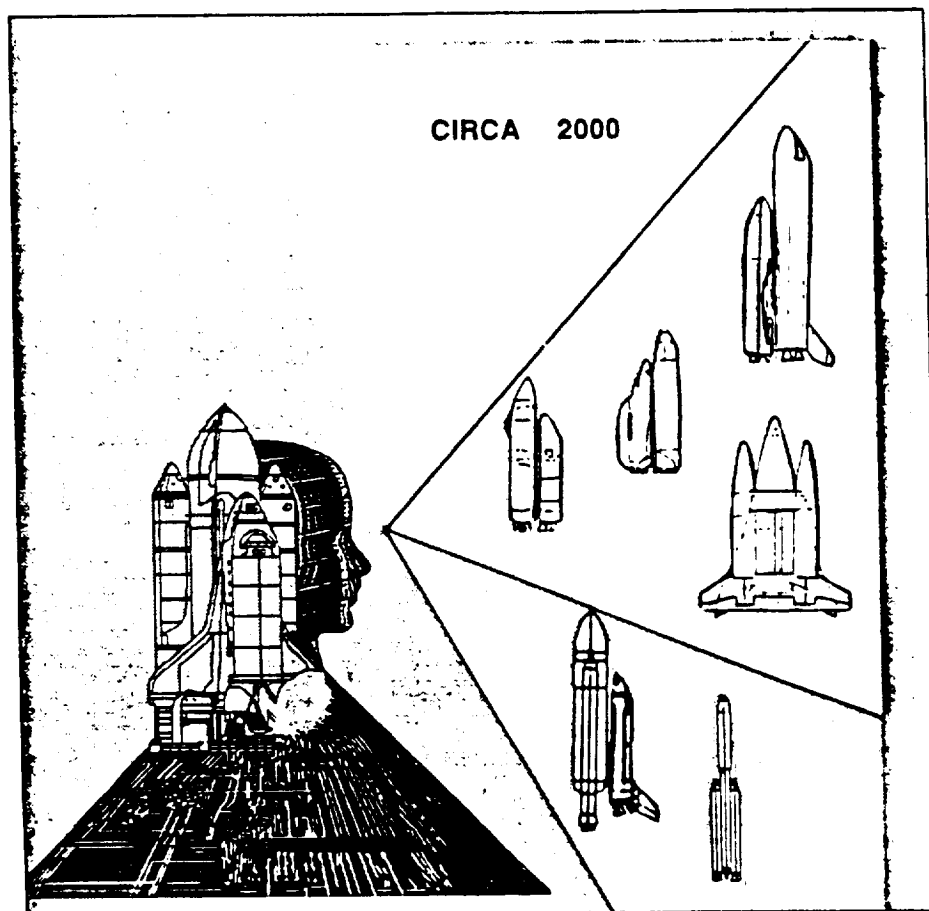
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Shuttle Ground Operations Efficiencies/Technologies Study

AEROSPACE OPERATIONS



**PHASE 3 ADDENDUM TO PHASE 2
FINAL REPORT - Volume 6 of 6**

51-L

WORK VOLUME INDICATORS

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ACRONYMS and ABBREVIATIONS

A&E	Architects and Engineers
ADABAS	Automated Data Base Systems
ADF	Automated Display Finder
ADP	Automated Data Processing
AGOSS	Automated Ground Operations Scheduling System
ALERT	Acute Launch Emergency Reliability Tip
AOA	Abort Once Around
APU	Auxiliary Power Unit
ASE	Airborne Support Equipment
ATE	Automatic Test Equipment
ATO	Abort to Orbit
AWCS	Automated Work Control System
BOC	Base Operations Contract(or)
BTU	British Thermal Unit
C/A	Compressed Air
CAE	Computer Aided Engineering
CALS	Computer Aided Logistics System
CAM	Computer Aided Manufacturing; Computer Communication Matrix
CAT	Category
CCAFS	Cape Canaveral Air Force Station
CCBD	Configuration Control Board
CCC	Complex Control Center
CCMS	Checkout, Control and Monitor System
CDDT	Countdown Demonstration Test
CDS	Central Data system
CFM	Cubic Feet per Minute
CIAR	Cargo Integration Assembly Record
CIG	Cargo Integrity Group
CIL	Critical Items List
CITE	Cargo Integration Test Equipment
CIU	Computer Interface Unit
CLS	Contingency Landing Site
C/O	Checkout
C of F	Construction of Facilities
COMM	Communications
CPU	Central Processing Unit
CR	Control Room; Change Request
CSN	Central Summing Network; Computer Summing Network
CT	Crawler Transporter
CVAS	Configuration Verification Accounting System
DA	Data Acquisition
DAS	Data Acquisition System
DB	Data Base
DBMS	Data Base Management System
DC	Direct Current
DCR	Data Change Request
DE	Design/Development Engineering
DOD, DoD	Department of Defense
DFRF	Dryden Flight Research Facility
DIC	Due-in-Contractor
DIR	Due-in-Repair
DIX	Due-in-Exchange
DM	Data Management; Document

ACRONYMS and ABBREVIATIONS
(Continued)

DPS	Data Processing System
DR	Discrepancy Report
DRA	Drawing Release Authorization
DRL	Data Requirements List
DWG	Drawing
ECS	Environmental Control System
EG&G	Base Operations Contractor
EI	End Instrument; Engineering Instruction
EMCD	Electro-mechanical Control Document
EO	Engineering Order
EOM	End-of-Mission
ESR	Engineering Support Request
ET	External Tank
ETA	External Tank Attachment
FCE	Flight Crew Equipment
FCEF	Flight Crew Equipment Facility
FKF	Flight Kit Facility
FMEA	Failure Modes and Effects Analysis
FMS	Flight Management System
FRCS	Forward Reaction Control System
FRR	Flight Readiness Review
FRSI	Felt Reusable Surface Insulation
FSS	Fixed Surface Structure
FY	Fiscal Year
GHE	Gaseous Helium
GH ₂ , GH ₂	Gaseous Hydrogen
GIDEP	Government-industry Data Exchange Program
GLS	Ground Launch Sequence
GN ₂	Gaseous Nitrogen
GO ₂ , GOX	Gaseous Oxygen
GOAL	Ground Operations Aerospace Language
GPM	Gallons Per Minute
GSE	Ground Support Equipment
GTSI	Grumman Technical Services, Inc.
H/E	Heavy Equipment
HGDS	Hazardous Gas Detection System
HMF	Hypergol Maintenance Facility
HP	Horsepower; Hewlett Packard
HVAC	Heating, Ventilating, and Air Conditioning
H/W	Hardware
HZ	Hertz, Cycles per Second
IAH	International Association of Machinists
IBEW	International Brotherhood of Electrical Workers
ICD	Interface Control Document
ICP	Instruction Control Point
ICR	Instruction Change Request
IDMM	Intermediate Depot Maintenance Manual
IEAS	Integrated Electronics Assembly
I/F	Interface
IFA	In-flight Anomaly
ILS	Integrated Logistics System

ACRONYMS and ABBREVIATIONS (Continued)

IMIS	Integrated Maintenance Information System
INC	Installation Notification Card
IOMI	Integrated O&M Instruction
IPR	Interim Problem Report
IRN	Interface Revision Notice
IWG	Interface Working Group
JC	Job Card
JSC	Johnson Space Center
K	Thousand
KATS	Kennedy Avionics Test Set
KICS	KSC Integrated Control Schedule
KIMS	Kennedy Information Management System
KMR	Kennedy Management Requirement
KSAR	Kennedy Special Action Requirement
KSC	Kennedy Space Center
KVA	Kilo-volt amps
LASS	Logistics Automated Storage System
LC	Launch Complex
LCC	Life Cycle Cost; Launch Control Center
LCOM	Lockheed Communications
LEO	Low Earth Orbit
LES	Launch Equipment Shop
LETF	Launch Equipment Test Facility
LiOH	Lithium Hydroxide
LMIS	Lockheed Management Information System
LRR	Launch Readiness Review
LSS	Launch Support Systems
LRU	Line Replaceable Unit
LPS	Launch Processing System
LSOC	Lockheed Space Operations Co.
LTD	Lockheed Test Director
M	Million
MCR	Modification Change Request; Master Change Record
MDAC	McDonnell Douglas Astronautics Company
MDD	Mate-demate Device
MERL	Material Equipment Requirements List
MH	Manhours
MIC	Management Information Center
MLP	Mobile Launcher Platform
MMACS	Material Management and Control System
MMU	Manned Maneuvering Unit
MP	Management Procedure
MRAS	Mass Memory Release Authorization Sheet
MRB	Material Review Board
MS	Material Specification
MSC	Material Service Center
MSBLS	Microwave Scanning Beam Landing System
MSFC	Marshall Space Flight Center
MTBF	Mean-Time Between Failure
MTI	Morton-Thiokol Inc.
MTTR	Mean-Time to Repair
NASA	National Aeronautics and Space Administration

ACRONYMS and ABBREVIATIONS (Continued)

NDE	Non-Destructive Evaluation
NEMS	NASA Equipment Management System
NLG	Nose Landing Gear
NRP	National Resources Protection Plan
O2	Gaseous Oxygen
O2N2	Breathing Air
O&C	Operations and Checkout Building
OEX	Orbiter Experiment
OJT	On-the-Job Training
OIS	Operational Intercom System
OIR	Operations Integration Review
O&M	Operations and Maintenance
OMC	Operations Management Center
OMD	O&M Documentation
OMI	Operations and Maintenance Instruction
OMP	Operations and Maintenance Plan
OMRF	Orbiter Maintenance and Refurb. Facility
OMRSD	Operational Maintenance Requirements and Specifications Document
OMS	Orbital Maneuvering System
OPC	Operations Planning Center
OPF	Orbiter Processing Facility
OPS	Operations
ORB	Orbiter
OSHA	Occupational Safety and Health Act
OSCR	Orbiter Software Change Request
OSF	Orbiter Support Facility
OTC	Orbiter Test Conductor
OTV	Operational Television
OV	Orbiter Vehicle
PAA	Pan American World Services, Inc.
PAPI	Precision Approach Position Indicator
PC	Printed Circuit; Personal Computer
PCR	Payload Changeout Room; Program Change Request
PDI	Payload Data Interleaver
PDR	Preliminary Design Review
PGHM	Payload Ground Handling Mechanism
PGOC	Payload Ground Operations Contract(or) (MDAC)
PIRN	Preliminary Interface Revision Notice
PL, P/L	Payload
PLB	Payload Bay
PLDD	Property Lost, Damaged or Destroyed
PMOMI	Preventive Maintenance O&M Instruction
PMP	Performance Management Report
PMRB	Prime Material Review Board
PO	Purchase Order
POL	Petroleum, Oil and Lubricants
PP&C	Process Planning and Control
PPM	Payloads Project Manager
PR	Problem Report; Purchase Request
PRACA	Problem Reporting and Corrective Action
PRC	Planning Research Corp.
PRCBD	Program Review Control Board Directive
PRD	Preliminary Requirements Document
PSM	Project Support Manager
PSP	Processing Support Plan

ACRONYMS and ABBREVIATIONS (Continued)

PYRO	Pyrotechnic
QA	Quality Assurance
QD	Quick Disconnect
QPR	Quality Paper Review
RCN	Requirements Change Notice
RCS	Reaction Control System
R&D	Research and Development
RIC, RI	Rockwell International Corporation
RM&QA	Reliability, Maintainability and Quality Assurance
RMS	Remote Manipulator System
ROM	Rough-Order-of-Magnitude
R&PM	Research and Program Management
RPS	Record and Playback System
RPSF	Remote Processing and Storage Facility(s)
R/R, R&R	Repair/Replace
RS&H	Reynolds, Smith & Hills
RSS	Rotating Service Structure
RTLS	Return to Landing Site
RUMS	Rockwell, USBI, Martin-Marietta GOAL Development Support
SAIL	Shuttle Avionics Integration Lab
SCAN	Selected Current Aerospace Notices
SCF	Standard Cubic Feet per Minute
SCA	Shuttle Carrier Aircraft
SEMA	System Equipment Move Authorizaton
SEPAR	Shuttle Electrical Power Analysis Report
SI	Specification Index
SIAPP	Systems Integration Assurance Program Plan
SICL	Surveillance Inspection Check List
SID	Standard Interface Document
SIMS	Shuttle Integrated Management System
SLF	Shuttle Landing Facility
SMS	System Schematics
SOCS	Support Operations Computer System Steering Committee
SPC	Shuttle Processing Contractor (Lockheed)@@
SPDMS	Shuttle Processing Data Management System; Shuttle Property Management System
SPI	Standard Practice Instructions
SR	Support Request
SRB, SRBs	Solid Rocket Booster(s)
SRM, SRMs	Solid Rocket Motor(s)
SSME	Space Shuttle Main Engine(s)
STC	Site Test Conductor
STP	Shuttle Technology Panel
STS	Space Transportation System; Shuttle Transportation System
S\W	Software
TAIR	Test Assembly Inspection Record
TAL	Transoceanic Abort Landing
TBC	Tank/Booster Test Conductor
TC	Test Control
TCD	Test Control Document
TCDT	Terminal Countdown Demonstration Test

ACRONYMS and ABBREVIATIONS
(Continued)

TCTI	Time Compliance Test Instructions
T&C/O	Test and Checkout
TE	Test Engineering
TIS	Technology Identification Sheet
TOP	Technical Operating Procedure
TP	Test Point; Test Plan
TPS	Thermal Protection System; Test Preparation Sheet
T/S	Test Setup
TSM	Tail Service Mast
TSMO	Test Support Management Office
T&CN	Telemetry & Communication Network
TV	Television
TVC	Thrust Vector Control
UMB	Umbilical
UPR	Unresolved Problem Report
UPS	Uninterruptible Power Supply
USI	United Service Associates
VAB	Vehicle Assembly Building
VAFB	Vandenberg Air Force Base
VDC	Volts DC
VHF	Very High Frequency
VITT	Vehicle Integration Test Team
VLS	Vandenberg Launch Site
WAD	Work Authorization Document
WBS	Work Breakdown Structure
WSB	Water Spray Boiler
WSSH	White Sands Space Harbor
WTI	Wiltech, Inc.
WVI	Work Volume Indicators
51-L	NASA Space Shuttle, 25th Launch, 1-28-86, orbiter Challenger and crew lost

1.0 INTRODUCTION

This document is intended to assist space transportation systems designers in understanding the magnitude of contemporary ground processing operations as a function of vehicle configuration/systems/facilities/GSE and management techniques/organizations. It is a condensed compilation of space shuttle ground processing functions, headcount, and work volume indicators for preparation of the Challenger's last mission, 51-L. The data herein are intended to show why it required 6110 people to accomplish the repetitive vehicle-related ground support operations at Kennedy Space Center during Nov/Dec 1985. Although this is a large number of people, it actually represents only one-half of the KSC dedicated contractor and civil service headcount necessary to support processing and launch of the Space Shuttle.

51-L was the 25th shuttle launch and represented a program entering a "mature" status. Life cycle costs (LCC) for the STS are keystone to its utilization and directly affect considerations for future orbital access vehicles. The Shuttle Processing Contract (SPC) work-load-driven headcount and vehicle turnaround time are, of course, a very significant fraction of that LCC. Intent of this particular document (and the entire SGOE/T Study in general) is to point out the surprisingly large magnitude of ground processing operations resulting from the complexity of "conventional" launch vehicle design, usually unsuspected by the design world. Prime references for the data were "SPC Bottoms Up Manpower Review", June 1987; SPC organization charts, and SPC personnel tabulations.

This study identifies in earlier reports that the smallest fiscal-year actual cost to LEO for a pound of payload occurred in FY85 (8 flights) and closely approached \$5500. Current goals for next-generation vehicles are pushing for \$300/lb to LEO; a very highly desirable goal, perhaps mandatory for United States viability in space. The life cycle cost triangle of flight hardware, processing facilities/GSE, and headcount, must be dramatically and radically reduced. The key is SIMPLICITY. The processing scenario, and life cycle cost, are almost totally driven by vehicle configuration.

It should be noted that data herein apply only to the SPC and do not address KSC Payload Ground Operations and Base Operations Contracts (PGOC, BOC) contributions to shuttle LCC. Those further interested in Shuttle ground support operations and headcount may find Phase 2, SGOE/T Study report Volume 6, "Circa 2000 System", of value. Appendix A "Headcount Estimation" contains a moderately detailed presentation of SPC work scope and headcount by WBS to the fourth digit. Appendix B "Ground Processing Timelines" contains actual turnaround timeline data for 51-L by major work categories and related prime work authorization documents (WADs). This document and the Volume 6 appendixes represent a concise and factual treatise on state-of-the-art, manned, launch vehicle ground processing scope, functions, time, and headcount. These data represent the normal response of a competent major U.S. aerospace contractor to the contemporary technical management environment and overall vehicle/processing configuration design requirements.

In summary, this document, centering primarily on 51-L data, provides the following:

- o SPC responsibilities/functions and tasks
- o SPC headcount summaries keyed to functions and systems
- o Work volume indicators and historical data
- o Assists vehicle/systems designers in trade studies by providing a feel (and the available data) for the large magnitude of ground processing operations necessary to support contemporary designs.

The data are presented in the following 12 distinct organizational sections. In general each section will define areas, functions or tasks, headcount breakdown, and work volume indicators, commensurate with format of the available source. In many cases the headcounts are "reconstructed" from the references as no single source exists, or was required at the level under study. All values are rounded to full heads to avoid fractional data. Accuracy is estimated at ± 1 head for at least 95% of the listings shown. Headcount of the 12 prime functional sections is shown as a prelude to the more detailed data that follows.

1.1 SPC POPULATION (Nov/Dec 1985)

<u>ORGANIZATION</u>	<u>SYSTEM/FUNCTION</u>	<u>PRE-51-L</u>
1. PROCESS ENGINEERING	FLIGHT VEHICLE/GSE ENGRG.	500
2. SUSTAINING ENGINEERING	FACILITIES/GSE DESIGN/MODS	132
3. PAYLOAD INTEGRATION	CARGO INSERTION	108
4. SR&QA	SAFETY AND QUALITY	549
5. SHUTTLE DATA SYSTEMS	LPS/SPDMS SOFTWARE	436
6. GRUMMAN (GTSI)	LPS, INSTRUMENTATION/ CALIBRATION	713
7. SUPPORT OPERATIONS	FACILITIES/GSE O&M AND COMMUNICATIONS	1030
8. LOGISTICS	MATERIEL CONTROL/ENGRG.	583
9. LCC OPERATIONS	TEST SUPPORT MGMT./ LCC OPERATIONS	362
10. OPERATIONS	ORBITER O&M/PROCESSING	1025
11. THIOKOL (MTI)	ET/SRB PROCESSING	341
12. BUSINESS MANAGEMENT	CONTRACTS/FINANCE ETC.	331
	TOTAL	6110

The above organizations and headcount represent only LSOC and its major subcontractors such as GTSI and MTI. Less significant subcontracts such as document services (BAMSI), janitorial (USAI), et al, are not presented. The LSOC subcontract to Rocketdyne for SSME O&M at KSC is identified as a supplement in the Operations section. Note, also, that the SPC was processing four orbiters in the Nov/Dec 85 timeframe. Assignment of headcount by vehicle is not possible with the available data sources. This is a significant, but undefined consideration in the Operations (orbiter O&M) and Thiokol (SRB/ET processing) sections of this report.

To place the above numbers in context the following manpower data are extracted from Phase 2, Volume 6 (page 89) of this study. Data are from the period of September 1985. The figures shown eliminate construction, tenant, expendable vehicle (CCAFS), and VAFB headcount.

1.2 KSC HEADCOUNT DATA (September 1985)

STS/KSC CONTRACTOR HEADCOUNT

SHUTTLE CONTRACTORS (SPC)	6,567
CENTER SUPPORT (BOC)	2,225
PAYLOAD PROCESSING (PGOC)	831
R&D SUPPORT	<u>744</u>

TOTAL 10,367

STS/KSC HEADCOUNT SUMMARY

CONTRACTOR	10,367
CIVIL SERVICE	<u>2,080</u>
TOTAL	12,447

Again extracting from the above reference (page 102), total recurring STS program cost per flight (for 8 FY85 flights) was shown to be \$273.7M. Nearly half (48.2%) of that cost is attributed to "Operations" and consists almost entirely of manpower. The launch operations fraction (within limitations of the data) is about 33% of total recurring operations non-hardware cost, or 16% of total cost-per-flight. To define operations the reference is partially reproduced below.

OPERATIONS Non-Hardware Costs

	<u>FY85 M\$</u>	<u>OPERS. %</u>
Launch Operations	347.5	32.9
Flight Operations	345.3	32.7
SSME	51.6	4.9
Contract Administration	17.1	1.6
Network Support	20.4	1.9
R&PM	274.2	26.0
Subtotal:	<u>1,056.1</u>	<u>100.0</u>

It is no surprise, therefore, that manpower is a very significant factor in LCC. Further, and repetitiously for this study, a vehicle design integrated with efficient ground processing (by design) and a significantly higher launch rate, will dramatically reduce manpower requirements and enable a payload-to-orbit cost-reduction factor of 10 or better.

1.3 SPC SKILL MIX

October 1987

<u>SKILLS</u>	<u>HEADCOUNT</u>	<u>% HC</u>
PRESIDENT/VPs, DIRECTORS, MANAGERS, SUPERVISORS	526	9.2
ENGINEERS (except S/W) AND TEST CONDUCTORS	1281	22.5

COMMAND, CONTROL, INFORMATION		11.8
o Programmers, S/W Engineers, Computer Operators	378	
o Planners/Schedulers	293	
FLIGHT VEHICLE AND FACILITIES (CRAFTS)		24.4
o Electrical/Electronic/Communications	504	
o Mechanical/TPS/Fabrication	832	
o Logistics Storekeeper/Expeditors/Drivers	57	
UNTABULATED ADMINISTRATIVE		32.1
o QA, Safety, Secretarial, Analysts, Clerks, Security, Business, Human Resources, etc.	<u>1,828</u>	<u> </u>
Total	5,699	100.0

2.0 PROCESS ENGINEERING

Flight Vehicle/GSE Engineering; 51-L Headcount = 500

2.1 **RESPONSIBILITY** - System engineering for performance of shuttle flight hardware ground processing, launch operations, and KSC flight operations support, including repetitive operations and maintenance of assigned equipment and systems.

<u>AREA</u>	<u>FUNCTION</u>
Firing rooms (4)	Shuttle test teams
Operational support facility	DOD payload integration area
Hypergolic Maintenance Facility (HMF)	Left & right aft pod & FRCS c/o
Data review facility	Engineering review and storage
VAB hi-bay cells (4)	ET, SRB, orbiter, MLP, and P/L canister work
Pads (2)	Propellant facilities, rotating and fixed service structures, etc.
SRB Rotation Processing & Surge Facility (RPSF)	Storage/handling of SRB segments
Orbiter Processing Facility (OPF)	Orbiter service/deservice & checkout
Orbiter Maintenance & Refurbishment Facility (OMRF)	Orbiter bay for mod's & maintenance
Ordnance Storage Facility (OSF)	Storage for pyrotechnic/ordnance
Mate-Demate Device (MDD)	Shuttle carrier a/c mate & demate
Launch Equipment Test Facility (LETf)	Umbilicals & mechanical support dev.
Shops & labs	Avionics labs, wheel & tire shop, SSME shops, pyro labs, battery lab, LIOH, etc.

2.1 RESPONSIBILITY (Continued)

AREA FUNCTION

Kennedy avionics test set	Flight hardware avionics test bed
Comm & tracking station	Test sets plus interface checkout
Contingency landing sites	Continental & non-continental U.S. negotiated orbiter landing sites.
Primary & alternate landing sites	DFRP, KSC & VSSH
Shuttle avionics integration lab	Shuttle avionics to LPS I/P checkout
Vandenberg launch & landing support	WTR shuttle launch/landing facility
Stennis Space Center	SSME testing/firings
Development center production	Shuttle system/design/develop/test

2.2 PROCESS ENGINEERING TASK CATEGORIES

1. General Processing Support
 - o WAD prep/process/closure
 - o LPS support
 - o Configuration/requirements change assessments
2. Vehicle Checkout
 - o Subsystem testing
 - o Integrated testing
 - o Conduct data reviews/identify anomalies or unusual trends
 - o OMI/JC maintenance
 - o Special test requests (B-45, KSARs, other)
 - o Verification of connector integrity
3. Vehicle Modifications
 - o Review/assess changes
 - o Generate CIAR documents
 - o Support program level II/III reviews
 - o Generate implementation paper (if approved)
 - o Verify changes made correctly
 - o Generate/obtain approval of TPS mod sheets
 - o Verify WAD/implementation paper satisfies design engineering requirements
 - o Track mod status thru implementation/retest/complete
4. In-Flight Anomaly Resolution
 - o In-Flight Anomaly (IPA) resolution
 - o Review flight data for IPA identification
 - o Participate in IPA telecons with JSC/MSPC
 - o Coordinate problem descriptions/troubleshooting plans via telecons
 - o Generate IPR's and perform IPR processing
 - o Report T/S results to telecons
 - o Evaluate results - recommend dispo
 - o Coordinate dispo via telecon for approval

4. In-Flight Anomaly Resolution (Continued)
 - o Dispo IPR for upgrade/closure
 - o Coordinate final resolution via telecon
 - o Report closure of IFA
 - o Keep flight crews informed on IFA status
5. Commit to Launch
 - o All OMRSD are satisfied/waivered/excepted
 - o All LCC are satisfied/waivered
 - o All CVAS configuration discrepancies are resolved
 - o All CIG's are successfully retested/waived
 - o All IPR's are resolved/closed
 - o All PR's are MRB'd/closed/deferred
 - o All pertinent test data has been reviewed and anomalies identified.
 - o Overall performance is in no way known/thought to be of concern for accomplishment of overall mission objectives.
 - o Support KMR's, rollout reviews, and readiness reviews with detailed presentations on major processing anomalies, unexplained anomalies, and waivers/exceptions.
 - o Develop Ground Launch Criteria (GLS) requirement from LCC
 - o Verify GLS implementation of the LCC
 - o Coordinate LCC with all design centers
6. GSE Processing Support
 - o Subsystem testing
 - o Integrated testing
 - o Conduct data reviews/identify anomalies
 - o OMI maintenance
 - o Special test requests
 - o Verification of connector integrity
(retest only -- no formal CIG)
 - o GSE modifications
 - o Commit to launch countdown/test support
 - o Participate in GSE design reviews
 - o Assess impacts for ICD changes and initiate required GSE changes
 - o Support on-going GSE FMEA/CIL reviews resulting from system mods or anomalies
 - o Manage KSC shop aids classification /authorization.
7. Processing Improvements
 - o Support inter/intra department meetings aimed at process improvements
 - o Generate ESR's to improve vehicle, GSE, or software support features/capabilities
 - o Support the development of KATS, LITS, SCAN, SPDMS II, tile automation
 - o Initiate/support R&D activities to improve processing
 - o Tile bond verifications
 - o Tile step & gap measures
 - o Radiator ding mapping
8. Training
 - o Maintain engineering learning center
 - o Develop/teach engineering courses (paperwork, etc.)
 - o Develop/maintain Engineering System Training Manuals/handbooks
 - o Maintain engineering certification/recertification
 - o Develop/maintain simulation training programs
 - o Plan/conduct and participate in simulated launch countdowns
 - o Support LTTS development
 - o Classroom instruction attendance
 - o Self-education/system study

2.3 51-L HEADCOUNT SUMMARY

<u>OVERALL HEADCOUNT</u>	
Vehicle Processing	239
Vehicle Mods	29
Offline Processing	27
GSE Maintenance	90
GSE Modifications	20
General Process Support	30
Training	6
Mgmt/Staff/Clerical	59
Total:	<u>500</u>

Overtime averaged 30.6% during the "typical data week" January 1986 for a total equivalent headcount of 653.

PROCESS ENGINEERING ELEMENTS HEADCOUNT

SHUTTLE AND GROUND SUPPORT ENGINEERING	13
o Engineering Integration	2
- Project Engineering and Test Integration	--
. Test Project Engineering	24
. Project Engineering	40
o Process Systems Engineering	2
- Engineering Technology	12
- Site Liaison	23
- Electrical/Mechanical Systems Engrg.	2
. Electrical/Telecommunication Systems	40
. Avionics Systems	71
. Orbiter Mechanical/GSE Systems	63
- Fluid/Mechanical Systems Engineering	2
. Fluid Systems	61
. MPS/Cryogenic Systems	57
. Pad/Mechanical Systems	<u>88</u>
Total:	500

2.4 WORK VOLUME INDICATORS

Inflight anomaly resolution (previous flights)	30 anomalies
Configuration/requirements change assessments	258 change packages
MCR/CR	40
DCR/OSCR	83 (Software)
RCN's	15
ESR's	29
TCTI	47
MRAS	44

Planned WAD prep/processing/closure

753 WADS

OMI - NEW	14
JC - NEW	11
OMI - ICR	200
JC - ICR	189
TPS A & B	339
(75-100 pages, avg.- 200)	

Realtime WAD prep/dispo/closure

3429 WADS

Deviations	1200
IPR's	248
PR's	1271
TPS MOD Shts.	678
Exception/waivers	32
Building 45'S	30

Goal program dev. support/verification

75 RUMS

Connector integrity group copper path verif.

5000 paths

1000 connectors/flow

3.0 SUSTAINING ENGINEERING

Facilities/GSE Design and Modifications; 51-L HEADCOUNT = 132

3.1 **RESPONSIBILITY** - Classical design engineering functions for all SPC ground facilities, systems and equipment including planning, requirements development, budget formulation, scheduling and execution of engineering and modifications.

3.2 **51-L HEADCOUNT SUMMARY**

SUSTAINING ENGINEERING

Facility systems & equipment engineering	62
Pressure vessel/system certification	0*
System design analyses	2
Facility projects	11
Cost estimating/cost engineering	1
Activation/activation support	14
Operations support	8
Field engineering	2
Common/mod common support	9
Shop aids	1
Safety projects	6
Sensor development	1
CLS modifications	3
Special studies	4
OMI/OMRSD reviews	0
Engineering documentation (OMD)	0
Administration	8
Total	132

*No dedicated headcount circa 51-L preparations.

Note: Overtime data not available.

3.3 TASKS AND WORK VOLUME INDICATORS - Sustaining Engineering is one of 12 major SPC organizations and has a wide diversity of tasks. The data for tasks and work volume indicators and headcount will be addressed individually for each of the 17 secondary organizations.

1. FACILITY SYSTEMS AND EQUIPMENT ENGINEERING; 51-L Headcount = 62

Tasks: Documentation updates, investigation activities, hazard analysis/systems assurance analysis (HAA/SAA), new/projected design packages, engineering evaluations, DRA release activity, including systems such as pneumatics, electrical/electronic, propellants, pad water, HVAC/ECS, etc.

Work Volume Indicators: Responsible for 103,000 documents assigned to SPC.

2. PRESSURE VESSEL/SYSTEM CERTIFICATION AND RECERTIFICATION; 51-L Headcount = 0

Tasks: Provide and maintain KSC pressure vessel and system certifications, including design engineering analysis/drawings, implement schedules and funding support, develop "20 year" service plan, and update OMRSD's and OMI's. Post 51-L requirement.

Work Volume Indicators: 1700 pressure vessels, 70,000 system components.

3. SYSTEM DESIGN ANALYSES; 51-L Headcount = 2

Tasks: Perform analyses to improve program efficiency and effectivity, including cost, schedule, service life, risk reduction, fatigue life, launch damage, and hydraulic ground unit efficiency improvements.

Work Volume Indicators: Shuttle processing systems segregated into 30 like groups with a lead engineer assigned to each and directing support engineers for an average of 6 manmonths per month per system group.

4. FACILITY PROJECTS; 51-L Headcount = 11

Tasks: Provide general design engineering from SPC organizations to ensure design compliance; and development of forms 1509/1510 in response to NASA/DE task directive and/or CCBD.

Work Volume Indicators: Historical average of 75 on-going projects

5. COST ESTIMATING / COST ENGINEERING; 51-L Headcount = 1

Tasks: Provide cost estimating and cost engineering for facilities/systems and GSE projects, including C of F facility projects, form 1509/1510 submittal, assess A&E contractors, and construction contractor proposals.

Work Volume Indicators: Historical minimum of 45 projects.

6. ACTIVATION / ACTIVATION SUPPORT; 51-L Headcount = 14

Tasks: Provide activation and engineering support for construction contracts, including design reviews, monitor construction, perform walkdown inspections, prepare punch lists, conduct verification / validation testing and final turnover.

Work Volume Indicators: Forecasted 100 projects per year.

7. OPERATIONS SUPPORT; 51-L Headcount = 8

Tasks: Provide general operations support as necessary, including realtime immediate analysis/problem solving requiring design engineering participation.

Work Volume Indicators: Level of effort historically established at 32,000 hours/year

8. FIELD ENGINEERING; 51-L Headcount = 2

Tasks: Participate in PR/TPS/EO following disposition, including site representation from Support Engineering, and coordination/liaison between Operations, System Engineering and Support Engineering.

Work Volume Indicators: 60 to 80 jobs/month

9. COMMON/MOD COMMON SUPPORT; 51-L Headcount = 9

Tasks: VLS ESR/PR/EO response, coordinate team efforts, release engineering, maintain schedules, and render reports.

Work Volume Indicators: 15 projects/month forecast

10. SHOP AIDS; 51-L Headcount = 1

Tasks: Provide engineering for upgrade of shop aids for GSE, including system documentation, analysis, drawing, schematics, interface controls, and OMRSD's.

Work Volume Indicators: 1000 shop aids in approval cycle, 80 manhours documentation/aid. Anticipate 100 aids converted/year.

11. SAFETY PROJECTS; 51-L Headcount = 6

Tasks: Provide engineering for safety projects in the interest of reducing personnel and corporate risk.

Work Volume Indicators: 300 ESR's in system, most against unmet OSHA requirements. Estimate 50 projects worked/year.

12. SENSOR DEVELOPMENT; 51-L Headcount = 1

Tasks: Provide engineering to develop sensors to meet new requirements and obsolescence of existing equipment, including transducers to measure pressure, temperature, fluid flow, strain, force, acceleration, acoustic, vibration, fire, smoke, ultraviolet, etc.

Work Volume Indicators: 12 new specifications or major revisions expected/year.

13. CLS MODIFICATIONS; 51-L Headcount = 3

Tasks: Perform modifications as required at contingency landing sites, including systems such as MSBLS and PAPI/Ball bar lights at new or improved sites in Spain, Morocco, Gambia, Easter Island, etc.

Work Volume Indicators: 6 modifications or new installations expected/year.

14. SPECIAL STUDIES; 51-L Headcount = 4

Tasks: Provide engineering for special studies to improve operations or safety, including concepts with cost estimates and schedules.

Work Volume Indicators: 8 to 12 projects/year forecasted.

15. OMI/ OMRSD REVIEW; 51-L Headcount = 0

Tasks: Recurring review of all OMRSD's on critical systems in 16 categories when mod changes are accomplished by design engineering. Post 51-L requirement.

Work Volume Indicators: There are 152 OMRSD's for critical systems, 350 OMRSD's on non-critical systems, and 700 related OMI's. Total document page count is approx. 150,000 pages. 22,450 MH estimated for FY90.

16. ENGINEERING DOCUMENTATION; 51-L Headcount = 0

Tasks: Perform change actions on O&M documentation (OMD) and standard interface documentation (SID), including operational maintenance requirements and specifications documents (OMRSD), system schematics/ electro-mechanical control diagrams (SMS/EMCD), maintain LRU parts lists, prepare preliminary interface revision notices (PIRN), and coordinate with interface working groups (IWG). Post 51-L requirement.

Work Volume Indicators: There are 10 ICD's requiring incorporation of 15 IRN's / month. PIRN's occur at rate of 20/month creating backlog.

17. ADMINISTRATION; 51-L Headcount = 8

Tasks: Provide for SPC policy/direction by the director's office, including staff functions, including budgeting, general personnel management, control/tracking safety items, work tracking, etc.

Work Volume Indicators: Unquantified level-of-effort

4.0 PAYLOAD INTEGRATION

Payload Insertion Support; 51-L Headcount = 108

4.1 RESPONSIBILITY - Launch site, on-line, integration of STS payloads, experiments, orbiter experiments, and flight crew equipment; including advanced planning, review and assessment, implementation, performance verification, flight and ground systems configuration, and OMI's/TOP's.

4.2 51-L HEADCOUNT SUMMARY

PAYLOAD INTEGRATION

Management and Administration	4
Payload Integration Engineering	50
Payload Operations Integration	22
Payload Project Management	30
Facilities and Ground Systems	
Project Management	<u>2</u>
Total:	108

Note: Overtime annotated in references as 18-19% (40% in P/L operations integration).

4.3 TASKS AND WORK VOLUME INDICATORS - Payload Integration is one of 12 major SPC organizations. The data for tasks and work volume indicators are presented individually for 5 secondary organizations, and 17 functional sub-groups as shown below.

1. Management and Administration
2. Payload Integration Engineering
 - a. Flight Crew Systems
 - b. Optics
 - c. MLP/Pad Checkout
 - d. Interface Testing (Payload to Orbiter)
 - e. Orbiter Experiment (OEX) Processing
 - f. Payload Bay Reconfiguration
 - g. Payload Handling
 - h. Off-Line Payload Integration Hardware Processing
 - i. Pad/PCR, GSE/Facility System Maintenance/Modifications
3. Payload Operations Integration
 - a. OPF Operations
 - b. Off-Site Landing Operations
 - c. Mission Equipment Operations
 - d. Pad Operations
4. Payload Project Management
 - a. Project Integration
 - b. Project Engineering
 - c. Project Planning and Support
 - d. Contamination and Material Control
5. Facilities and Ground Systems Project Management

1. MANAGEMENT AND ADMINISTRATION; 51-L Headcount = 4

Tasks: Provide overall organizational policy, direction, and personnel and budgetary administrative support.

Work Volume Indicators: Unquantified level-of-effort

2. PAYLOAD INTEGRATION ENGINEERING; 51-L Headcount = 50

a. Flight Crew Systems

Tasks: Stow and de-stow flight crew systems equipment.

Work Volume Indicators: Requirements - 60 pages/mission; WADs/TPS- 60 pages/mission; OMI - 2600 pages/mission

b. Optics

Tasks: Develop/perform procedures (OMI's) to optically align orbiter systems and STS elements (orbiter, SRB, ET)

Work Volume Indicators: Data calculation sheets - 30/flow; WAD pages - 45/flow

c. MLP/Pad Checkout

Tasks: Develop/conduct OMI's to configure and verify T-0 electrical lines at MLP and pad to support payloads.

Work Volume Indicators: 350 OMI pages/mission

d. Interface Testing (Payload to Orbiter)

Tasks: Develop/conduct OMI's

Work Volume Indicators: Requirements - 200 pages/mission; Procedures - 300 pages/mission; on-station firing room support - 25 man days/mission.

e. Orbiter Experiment (OEX) Processing

Tasks: Install and checkout OEX's

Work Volume Indicators: Procedures - 450 pages/mission; on-station support -50 man days/mission

f. Payload Bay Reconfiguration

Tasks: Prepare/install/remove payload integration flight kit hardware

Work Volume Indicators: Configuration requirements review -450 pages/mission; Procedures - 700 pages/mission; Problems - 160 pages/mission; Procedures Updates - 100 pages/mission

g. Payload Handling

Tasks: Install/remove payload from orbiter, including PGHM configure

Work Volume Indicators: Requirements -150 pages/mission; Procedures update - 250 pages/mission; meetings attended/supported - 20/mission; extensive training and certification required for 8 people.

h. Payload Integration Engineering

Tasks: Off-line payload integration hardware processing/modifications

Work Volume Indicators: Manpower not flow-related; design center modifications - 10 to 15/year; mod instructions - 75 pages; problem resolution - 75 pages; requirements review - 150 pages.

i. Pad/PCR, GSE/Facility System Maintenance/Modification

Tasks: Develop/maintain procedures; design and on-line engineering

Work Volume Indicators: Manpower not flow-related; 2 pads/2 PGHM's/2 PCR's; procedure updates - 25 pages; procedure development - 10 pages; problem disposition - 400 pages; 3 to 4 design / site meetings / week; data collection - 100 pages

3. PAYLOAD OPERATIONS INTEGRATION; 51-L Headcount = 22

a. OPF Operations

Tasks: Coordinate/direct on-line operations to configure orbiter, experiments, and flight crew equipment.

Work Volume Indicators: Unquantified - driven by launch rate

b. Off-site Landing Support

Tasks: Schedule/coordinate/provide realtime direction for mission-unique early de-storage; flight crew de-suiting; crew module de-storage; data shipment, etc.

Work Volume Indicators: Unquantified - driven by launch rate

c. Mission Equipment Support

Tasks: Manage and operate PCEF, PKF, OEX, and RMS processing areas in the VAB.

Work Volume Indicators: Unquantified - driven by launch rate

d. PADs

Tasks: Consolidate/direct payload operations at pads

Work Volume Indicators: Unquantified - driven by launch rate

4. PAYLOAD PROJECT MANAGEMENT; 51-L Headcount = 30

a. Project Integration

Tasks: Provide Payload Project Managers (PPM) for each mission to serve as SPC focal point for all payload integration activity

Work Volume Indicators: Unquantified - driven by flight rate

b. Payload Project Engineering

Tasks: Provide technical integration support to PPMs; coordinate on-line testing

Work Volume Indicators: Unquantified - 2 to 3 years advanced planning required; position requires extensive training and experience

c. Project Planning and Support

Tasks: Develop payload programmatic/project documentation including DOD PRD's, Launch Site Support Plan, Off-site Operations Plan, Operations Requirements/Directives, Mission Master Schedule, Payload/Orbiter Processing Plan, Shuttle/Payload Integration Plan.

Work Volume Indicators: See Section 4.3, part 2, Payload Integration Engineering (paragraphs a. through i.) above for tasks supported; payload requirements and document library contains 2500 - plus documents

d. Payload Project Management

Tasks: Develop/implement/maintain SPC contamination and material control programs for orbiter and payload on-line processing facilities

Work Volume Indicators: Shuttle Contamination Control Plans (Environmental Sampling Plan; OPF Payload Operations Plan; PCR Payload Operations Plan); Requirements - 200 pages; Technical Operations Procedures (Payload Bay Cleaning - OPF; OPF High Bay Cleaning; Crew Compartment Cleaning; Payload Bay Cleaning; PCR Cleaning)

5. PAYLOAD FACILITY AND GROUND SYSTEMS PROJECT MANAGEMENT; 51-L Headcount = 2

Tasks: Coordinate/track/monitor modifications to payload-related facilities and ground systems

Work Volume Indicators: 24 payload-related mods mandatory for STS-26R, incorporating 36 ESRs; 12 mods estimated for each mission by FY90.

5.0 SAFETY, RELIABILITY, MAINTAINABILITY AND QUALITY ASSURANCE

SRM&QA; 51-L Headcount = 549

5.1 RESPONSIBILITY - Safety: Provide a safety program for a 6,000 person company including development and maintenance of a mishap prevention and corrective action program and a responsive hazardous waste management program.

Reliability/Maintainability and Quality Assurance: Provide management, direction, and implementation of policy and procedures to ensure compliance with contractual R, M & QA requirements, including assessment, inspection/surveillance and corrective action.

5.2 51-L HEADCOUNT SUMMARY

OVERALL HEADCOUNT

Director and Staff	5
Safety	
o Management	6
o Operations	
- Morton Thiokol	13
- Lockheed	37
o Engineering (Lockheed)	27
RM&QA	
o Management	15
o Reliability, Maintainability	41
o Quality Assurance	
- Morton Thiokol	53
- Lockheed	295
o Quality Engineering	
- Morton Thiokol	8
- Lockheed	49
Total:	549

SRM&QA ELEMENTS HEADCOUNT

Safety	
o Management	
- SPC Safety Director's Office	6
o Operations	
- Morton Thiokol	
. VAB/RPSF/Hangar AF	13
- Lockheed	
. Management and Administration	4
. OPF/HMF/SLF/DFRF/OMRF	17
. Pads A & B/MLPs/Crawlers	10
. LCC	6
o Engineering (Lockheed)	
- Management	3
. Safety Engineer Manager's office	
- Procedures review	8
- Occupational Safety and Health	4
- System Safety	12
o RM&QA	
o Director and Staff	20
o Reliability/Maintainability	
- Management and Supervision	4
- Design Reviews	6
- Analysis of equipment and facilities design	10
- Critical items list/OMRSD	2
- Quality data center	19

o	Quality Assurance	
-	Morton Thiokol	
.	Management and Administration	6
.	ET Processing	9
.	ET/SRB stack	15
.	Booster buildup	12
.	Access control	
-	RPSF	2
-	VAB	5
.	Hangar AF	1
.	Receiving inspection	1
.	Mechanical shop	1
.	Surveillance	1
-	Lockheed	
.	Management	2
.	Orbiter flight hardware inspection and test	115
.	GSE inspection	31
.	Facilities/LPS/comm receiving inspection	67
.	Job card structural/zonal inspection	25
.	Quality paper review	9
.	LCC-testing operation	28
.	HMF testing operation	14
.	TAIR system maintenance	0
.	Orbiter integrity clerk	0
.	Surveillance inspection	4
o	Quality Engineering	
-	Morton Thiokol	
.	Booster buildup - RPSF	1
.	VAB Processing High-bay 1 & 3	1
.	VAB Processing High-bay 2 & 4	1
.	Quality lab operations	1
.	Hangar AF disassembly operations	1
.	NDT - evaluation and measurements	1
.	Recurrence control	1
.	Quality planning	1
-	Lockheed	
.	Management	3
.	Prime material review board	1
.	Reports, procedures and quality awareness	1
.	GSE Quality Engineering	2
.	Trend analysis/recurrence control and problem assessment	9
.	GIDEP	1
.	Identify inspection points in TOPS	3
.	MRB/site support	10
.	NDE	2
.	Evaluate processing documentation procedures	2
.	Prepare inspection technical operating procedures	1
.	Provide historical record	2
.	Review Cat. 1, 1R, 2, 2R hardware TOPs	2
.	Quality performance measurement	1
.	Standard quality requirements for suppliers	1
.	Quality coding of procurement documents	1

o Quality Engineering
 - Lockheed (Continued)

. Common receiving/shipping inspection requirements	1
. Supplier approval/supplier rating	1
. Perform pre-award surveys and periodic supplier audits	1
. Airframe inspection	2
. Material and processes	2

Total: 549

5.3 TASKS AND WORK VOLUME INDICATORS - SRM & QA is one of 12 major SPC organizations. The data for tasks, work volume indicators, and headcount are presented for the organizational breakdown shown below.

SAFETY

1. Management
2. Operations
 - a. Morton Thiokol - VAB/RPSF/Hangar AF
 - b. Lockheed - OPF/HMF/SLF/DFRF/OMRF/PADS A&B/MLPs/CTs/LCC
3. Engineering (Lockheed)

RELIABILITY/MAINTAINABILITY AND QUALITY ASSURANCE

1. Management
2. Reliability/Maintainability
3. Quality Assurance -
 - a. Morton Thiokol- ET processing/ ET-SRB stack/RPSF/VAB/Hangar AF
 - b. Lockheed - facilities/GSE/LPS/Comm/LCC/HMF
4. Quality Engineering
 - a. Morton Thiokol - RPSF/VAB Bays 1,2,3,4/Qual lab/Hangar AF
 - b. Lockheed - PMRB/GSE/GIDEP/TOPS/MRB/NDE/LC-39/Industrial Area

SAFETY

1. Safety Management; 51-L Headcount = 6

Tasks: Directors Office; develop and maintain mishap prevention and corrective action programs, and hazardous waste management program.

Work Volume Indicators: Unquantified; 6000 person company program

2a. Morton Thiokol Operations; 51-L Headcount = 13

Tasks: Monitor hazardous operations, inspect facilities, review WADs, investigate/report/assess mishaps, perform daily toxic vapor checks

Work Volume Indicators: Unquantified

2b. Lockheed Operations; 51-L Headcount = 37

Tasks: Same as 2a.

Work Volume Indicators: Unquantified.

3. Safety Engineering; 51-L Headcount = 27

Tasks: Maintain a safety engineering program, procedures review, OSHA program, report mishaps, maintain trend analysis, review CAT I and II procedures.

Work Volume Indicators: Procedures reviewed - 12,000 to 19,000/year (OMI, STP, IDMM, job cards, ICR); 71 safety committees; annual review of 520 safety assurance analyses and approximately 400 ESRs.

RELIABILITY, MAINTAINABILITY, AND QUALITY ASSURANCE

1. RM & QA Management; 51-L Headcount = 15

Tasks: Overall management and direction for policy and procedures and ensure contract compliance including training/certification, SPC stamp program, audits and surveys

Work Volume Indicators: Unquantified

2. Reliability and Maintainability Engineering; 51-L Headcount = 41

Tasks: Determine, establish and promote quality activities in accord with NASA requirements and SPC policy; provide quality engineering for shuttle operations, GSE, facility operations; reliability analysis; maintainability analysis; critical items list/OMRSD; quality data center.

Work Volume Indicators: Manpower driven by number of new designs/changes and complexity. Estimate 5 projects initiated each week requiring 80 MH's/project. Reliability analyses estimated 5 additional projects initiated each week, of which 3 will be critical systems requiring in-depth analysis of 200 MH's/critical project. Maintainability analyses estimated at 5 new projects each week and 16 MH/project. CIL/OMRSD estimated 5 new projects/week, of which 3 are on critical systems. Quality Data Center receives, processes, microfilms, and indexes 200,000 pieces of documentation/flow; includes receipt/entry of 1600 connector mate/demate transactions per flow and receipt/entry of 1200 PR/DRs per week (this function for real-time support for PRACA and connector tracking database).

3a. Morton Thiokol Quality Assurance; 51-L Headcount = 53

Tasks: Determine, establish and promote quality assurance activities in accord with NASA requirements and SPC policy including QA supervision and administration for ET processing, ET/SRB stacking, booster buildup; access control monitors at RPSF, VAB, Hangar AF; receiving inspection; GSE preventive maintenance; QA surveillance at VAB, RPSF, Hangar AF.

3a. Morton Thiokol Quality Assurance (Continued)

Work Volume Indicators: 70-100 documents/week reviewed by QPR team; 3 OISR meetings/week; 150 to 200 OM/OMI manuals require update; 5 volumes of SPI's require maintenance; ET processing requires 24 days/flow; 6 to 9 modifications are made; 15 different OMI's run to make ET flight-ready; 30 to 50 PRs/DRs written and worked off; QA inspection simultaneously supports 2 flights (2 ET's, 4 SRB's); booster buildup requires 6 to 8 different QA tasks each shift; access controls at RPSF for 40 to 50 persons; 17 Surveillance Inspection Check Lists (SICL) performed each week - each SICL has 20 to 25 QA verifications.

3b. Lockheed Quality Assurance; 51-L Headcount = 295

Tasks: Determine, establish and promote quality assurance activities in accord with NASA requirements and SPC policy; inspect orbiter flight hardware, GSE; post-flight inspections (photography, dye penetrant, fusion welds, wing spar mods); GSE preventive and corrective maintenance inspections (VAD/OMI requirements, mods/repairs, potting, functional installations, continuity checks, alignments, sample results, fluid and gas connections, leak checks, decay checks, NDE, OPS, proof pressure tests); receiving inspections, electrical cable termination and ordnance inspections; calibration accountability; facilities inspections (CT shop, VAB, LES, MLPs 1-2-3, TAIR stations in OSF, proofload witness, OIS/OTV purge, MSBLS); job card inspections (Orbiter NDE, structural repair/mods/borescope, body flap, hatches, inner/outer skin, umbilicals, flight surface, control system, SSME removal, OMS removal, LRU replacements, vents); quality paper review team (QPR); LCC operations monitoring.

Work Volume Indicators: Effort driven by number of vehicles processed, launched, and off-site landings. Inspection personnel work an average of 289 documents/day (logistics - 100, LPS - 40, comm - 40, meas. - 57, fac. - 52). All vehicle inspections at maximum interval of 3 years. Inspection personnel review 600 to 700 documents/week in OPF high bay 1 and 2, VAB, LCC, Pads A and B, HMF, and SLF; daily and weekly reports to upper management identify document discrepancies and trends.

4a. Morton Thiokol Quality Engineering; 51-L Headcount = 8

Tasks: Support booster buildup operations in RPSF; review realtime paper, insert quality requirements; evaluate MRB dispositions; realtime problem solving; prepare QA TPS's and OMI's; support SRB stacking, ET and orbiter mate; support ET systems checkout and repair; operate quality laboratory; support SRB disassembly and post flight inspection at hangar AF; perform non-destruct testing (ultrasonic, fiber optics, laser enhanced videoprobe - SRB elements); recurrence control; quality planning/documents review.

Work Volume Indicators: Unquantified

4b. Lockheed Quality Engineering; 51-L Headcount = 49

Tasks: Administer Prime Material Review Board (PMRB) - TPS; maintain monthly RM & QA contract report, SPI's, and quality awareness program; GSE quality engineering; develop trend analysis/recurrence control; receive/screen/distribute GIDEP alerts; identify TOPs inspection points; MRB/site support; NDE (x-ray); ensure utilization of accept/reject criteria for process documents

4b. Lockheed Quality Engineering (Continued)

Work Volume Indicators: 3 prime MRB and tile PMRB meetings/week; review and status 35 deferred WAD's per flow with deviations and waivers; 30-plus quality SPI revisions/month; 110 quality awareness monthly poster updates; quality engineering support on 2500 - plus GSE items in OPP, VAB, MLP, SLP, and orbiter and flight hardware interface; GIDEP/week- 8 urgent data requests, -5 general document summary sheets, -2 SAFE alerts; 700 flight and 200 support operations/GSE TOP's processed per week (QE requires 2.0 hours/flight TOP and 0.5 hours/ support ops TOP. 56% of TOP's reviewed for inspection points are MRB/site support; 44% are preplanned OMI and TPS support; MRB/site support for 10-plus sites; 100-plus NDE operations per week (x-ray, mag particle, eddy current, ultrasonic, borescope); LC-39/Industrial Area Inspection - type TOP's require an average of 10 hours preparation (an average of 2 required weekly); quality performance measurement - 50-plus trend charts per week; quality coding of procurement documents - 3000-plus line items per month (2000 of which require establishment of applicable quality codes; common receiving/shipping inspection requirements - 2000 - plus QCI's maintained to support receiving and source inspection; supplier approval/supplier rating - 25 to 30 requests for new supplier quality approvals per week; monitor receipts of 800 - plus critical items from established suppliers; pre-award surveys and periodic supplier audits - 50-plus new surveys and 400 periodic reviews expected per year; airframe inspection 200-plus airframe OMRSD job cards and 150 zonal OMRSD job cards per vehicle per year; material processes evaluations - 30-plus continued acceptability investigations per month and 10 process investigations per month.

6.0 SHUTTLE DATA SYSTEMS

LPS/SPDMS Software; 51-L Headcount = 436

6.1 RESPONSIBILITY - Support post and preflight maintenance, checkout, testing, and launch operations. Prime component of the data systems is the Launch Processing System (LPS) which consists basically of the Checkout, Control, and Monitor Subsystem (CCMS); Central Data Subsystem (CDS); and Record and Playback System (RPS). Areas of responsibility include automated checkout and launch procedures, operations management support systems, change data processing, and on-line data analysis.

6.2 51-L HEADCOUNT SUMMARY

SHUTTLE DATA SYSTEMS

o Management/Staff	14
o LPS Engineering and Software Production	64
o LPS Application Software Development	98
o LPS System Software Development	118
o SPDMS	63
o Data Systems Integration	
- Requirements Integration	40
- Integration Technical Support	39
Total:	<u>436</u>

6.3 TASKS AND WORK VOLUME INDICATORS - Shuttle Data Systems is one of 12 major SPC organizations. Data tasks and work volume indicators, are presented for secondary organizations as shown below.

SHUTTLE DATA SYSTEMS

1. Management/Staff
 2. LPS Engineering and Software Production
 - a. LPS Engineering
 - b. LPS Application Software Development
 - c. LPS System Software Development
 3. Shuttle Processing Data Management System (SPDMS)
 4. Data Systems Integration
-

1. Management/Staff

Tasks: Provide for SPC policy/direction by the director's office, including staff functions, budgeting, general personnel management, control/tracking safety items, work tracking, etc.

Work Volume Indicators: Unquantified

2a. LPS Engineering

Tasks: Sustaining engineering for LPS hardware

Work Volume Indicators: Approximately 300 minicomputer systems and associated peripherals for CCMS, CITE, HMF, CCC, SAIL, CDS, and RPS.

2b. LPS Application Software Development

Tasks: Develop and maintain LPS application software for CDS and CCMS

Work Volume Indicators: Maintain 1700K lines of code for CDS and 5200K lines of code for CCMS.

2c. LPS System Software Development

Tasks: Sustaining engineering for LPS operating system software

Work Volume Indicators: Maintain 1000K lines of code for CCMS and 300K lines of code for RPS

Monthly change traffic for 2a,b,c (above): 148 PR's; 284 GOAL updates; 165 ESR's; 4 TCID builds; 72,000 function designators.

3. Shuttle Processing Data management System (SPDMS)

Tasks: Provide software development support for planning, controlling and managing ground operations and maintenance activities; system engineering support to SPDMS users for requirement definition/validation/training.

Work Volume Indicators: Maintain 1000K lines of code; approx. 200 users/month trained in PRACA and AGOSS; respond to 200 help calls/month; 1100 users on system; 5 large ESR's; 12 PR's; 1 major acquisition plan; 70 purchase requests/month.

4. Data Systems Integration

Tasks: Gather and integrate user requirements; configuration control for LPS and SPDMS H/W and S/W; resource management of LPS and SPDMS computers; develop and maintain LPS and SPDMS documentation and S/W quality assurance.

Work Volume Indicators: Generate and maintain 1200 page SPDMS requirements document; 165 CCBD's, ESR's, EI's, OSCR's, TCTI's/month; 23 board meetings/month; manage 1100 user ID's, work space and permissions; maintain 16 SPI's; produce 7 reports on disk space/performance; 141K pages/70 updates per month; 140 PR's, 284 GOAL updates, 142 flight S/W tapes per month; 228 data retrievals/month.

7.0 GRUMMAN (GTSI)

LPS H/W O&M, Instrumentation and Calibration; 51-L Headcount = 713

7.1 RESPONSIBILITY - Grumman Technical Services, Inc., one of 12 major SPC organizational elements, provides a wide range of test and calibration support to the SPC from a 5-element organization as follows:

1. Integrated Ground Operations Director (Business Operations)
2. Test Support
3. LPS O&M (CCMS, RPS, CDS)
4. Instrumentation and Calibration
5. Engineering Support

7.2 51-L HEADCOUNT SUMMARY

GRUMMAN - GTSI/LPS

o Business Operations	37
o Test Support	32
- Special Projects	13
o LPS O&M	58
- CDS Operations	110
o CCMS O&M	145
o Instrumentation	72
- Calibration	38
o Engineering Director	3
- Logistics	47
- Engineering Support	40
- Conference Management	48
- ATE/Test Tools	15
- Shops/Labs	55

Total: 713

7.3 TASKS AND WORK VOLUME INDICATORS

- 1. Integrated Ground Operations Director (Business Operations);
51-L Headcount = 37**
- 2. Test Support; 51-L Headcount = 45**

Tasks: Above items not addressed in detail. Organization chart shows: Test Support - integrated scheduling; integrated OMI's; vehicle and payload processing; AWCS; CAM's; training; ADF

Work Volume Indicators: Unquantified (see following items)

- 3. LPS O&M; 51-L Headcount = 313**

Tasks: Operate and maintain (O&M) all CCMS-type equipment sets for firing rooms 1,2,3,4; O&M cargo integration test equipment (CITE); O&M shuttle avionics integration lab (SAIL) at JSC, complex control center (CCC-facilities remote monitor and control), hypergol maintenance facility (HMF), and O&M of records and playback system (RPS); operate central data system (CDS).

Work Volume Indicators: 50 CCMS consoles and 160 computer systems and peripherals (firing rooms); 3 CCMS consoles and 15 computer systems (CITE); 2 CCMS consoles and 10 computer systems (SAIL); 5 CCMS consoles and 14 computer systems (CCC); 2 CCMS consoles and 5 computer systems (HMF); 5 computer systems, 42 analog recorders, 40 stripchart recorders, 40 decommutators, and several hundred telemetry modules (RPS); 14 large scale computers, I/O center for over 1400 users.

- 4. Instrumentation and Calibration; 51-L Headcount = 110**

Tasks: Operate and maintain (O&M) measurement systems on launch pads, MLP's, and LCC; O&M lightning warning and detection equipment; instrument calibration, repair and cleaning; operate wave analysis lab.

Work Volume Indicators: 300 channel system each pad, 100 channel system each MLP, 100 meteorological transducers and transmission equipment; 29 field mill sites, induced voltage measuring systems at each pad; 1,100 field calcs/month, 1,600 backlog; computer processed hardcopy plot records - 700/month, analog magnetic tapes - 6/month, digital magnetic tapes - 6/month, oscillograph records - 400 ft/month, 8-inch magnetic disk files - 20/month (wave analysis lab).

- 5. Engineering Support; 51-L Headcount = 208**

Tasks: Support LPS hardware and software; operate intermediate level maintenance facility (ILMF) for LPS LRU repair.

Work Volume Indicators: 10,000 LPS LRU's in system; 400 LRU's repaired/month.

8.0 SUPPORT OPERATIONS

Facilities/GSE and Communications; 51-L Headcount = 1030

8.1 RESPONSIBILITY - Support Operations includes the hands-on engineering and performance of vehicle processing facilities O&M, launch facilities O&M, and communications O&M.

Facilities O&M includes the following functions and systems (engineering and mechanic/electrician/technician):

- o Low voltage electrical power - 440/220/110 VAC, lights, generators, UPS, etc.
- o Pneumatics - compressors (shops and pads), nitrogen and helium purge gas supply systems.
- o HVAC/ECS - VAB, OPF, LCC, pads, portable HVAC and purge units, MLPs, C/Ts, PCR, and all processing or launch supporting facilities.
- o Industrial water systems - firex, structural deluge, sound suppression.
- o Heavy equipment - mobile cranes, prime movers, fork lifts.
- o Structures - C/Ts (2), MLPs (3), Pads A and B (FSS, RSS, PCR)
- o VAB cranes, doors, platforms, elevators
- o Work control, planning and scheduling, modification management
- o Technical shops (mechanical, electrical/electronic), chemical services (component refurb, chemical analysis)

Communications O&M includes the following engineering and technician system responsibilities:

- o Voice systems, wide-band transmissions, nav-aids
 - o Cable plant
 - o Communications services
 - o Communications design - significant work load added subsequent to 51-L (performed previously by four subcontractors under NASA-DE direction).
-

8.2 51-L HEADCOUNT SUMMARY

The following data represent the period 4th quarter 1985 (pre 51-L) and in a few cases are extrapolated from supplementary sources as the prime reference (SPC Bottoms-Up Manpower Review, June 1987) did not contain all entries.

FACILITIES O&M (667)

o DIRECTOR	7		
Resources Administrator	14		
Subtotal	<u>21</u>		
o FACILITIES FIELD OPERATIONS			
Manager and Staff	14		
Low Voltage Electrical	59		
Pneumatics	29		
HVAC/ECS	42		
Industrial Water	37		
Heavy Equipment	83		
C/T, MLP, Pad Structures	51		
Cranes, Doors, Platforms, and Elevators	90		
Complex Control Center (CCC)	<u>14</u>		
Subtotal	419	(1st quarter FY86 overtime averaged 30% engineering and shops)	
o FACILITY PLANNING AND CONTROL			
Manager	2		
Work Control	34		
Planning & Scheduling	23		
Modification Management	33		
Subtotal	<u>92</u>		
o FACILITY SHOPS AND LABS			
Manager and Staff	8		
Mechanical Shops	81		
Electrical/Electronic Shops	29		
Component Refurb (Chemical)	11		
Chemical Analysis	6		
Subtotal	<u>135</u>		

COMMUNICATIONS (363)

o Director (4)		o Cable Plant (54)	
o Voice Systems (124)		Supervisor	2
Supervisor	2	Engineering	8
Engineering	20	Cable	24
Shops	30	Wire	20
Secure	8	o Communications Services (35)	
O&M	64	Supervisor	4
o Navigation Aids (18)		Operations Management	8
o Wide Band Transmission (80)		Operations Analysis	17
Supervisor	2	Software	8
Engineering	12	o Communications Design & Dev. (46)	
OTV	22	Department	2
Data	21	Comm. Design	16
Shops	13	OIS-D Project	9
Color TV	10	Electronics Development Lab (EDL)	<u>21</u>
		Subtotal	<u>363</u>

Comm D&D is a workload added subsequent to 51-L. Numbers represent forecast.
EDL (only) at 51-L was 21.

8.3 WORK VOLUME INDICATORS

8.3.1 FACILITY FIELD OPERATIONS

LOW VOLTAGE ELECTRICAL

- o Secondary power distribution - 143 unit substations
- o Uninterruptible power systems - 31 units 4132 KVA
- o 28 VDC and 400 HZ - 7 systems
- o Portable generators - 150 units 1.5 to 300 KW
- o Visual landing aids KSC & CLS - 4 sites 8 runways/launch
- o Safety signal & hazard warning lights - 54 lights
- o Logistics facility equipment - 5 wire guide forklifts
- 7 automated storage retrieval systems
- o Grounding pads A and B

PNEUMATICS

- o GHE 7,216,639 SCF - 196 storage vessels
- o GN₂ 3,071,347 SCF - 5 systems
- o GO₂ 281,844 SCF - 5 systems
- o O₂N₂ 16,400 SCF - 2 systems
- o GH₂ 555,464 SCF - 5 systems
- o C/A 6,622 CFM - 36 compressors

In November 1985, a typical month, the SPC expended the following on propellants and gases:

GHE	@ \$56.00/MSCF	5,930 MSCF	\$332,100
GN2	@ 6.00/MSCF	65,000 MSCF	390,000
TOTAL:			\$722,100

LH2	@ \$ 1.35/lb.	430K lb.	\$580,500
L02	@ \$86.00/ton	1,910 tons	168,500
MMM	@ \$ 8.00/lb.	32,480 lb.	226,600

Intent of these "cost volume indicators" is to reveal for designers of future vehicles that the cost of purge and pressurization gases can be much larger than usually suspected. In this sample, they very nearly equal the cost of LH2 and L02 combined!

HVAC/ECS

- o Chillwater 8,861 tons - 14 systems 407 end items
- o Direct expansion 2,736 tons - 767 systems
- o Portable 120 tons - 11 systems
- o Hot-water 55,000,000 BTU's/Hr. - 17 systems 328 end items
- o Fan systems - 308 end items
- o Miscellaneous Systems - 435 end items

INDUSTRIAL WATER

- o Sound suppression
- o Firex systems 92,430 GPM
Pad's A and B, OPF, OMRP, VAB, MDD,
RPSF, BMF, 3 MLP's and MLP parksite
- o Potable water 350 GPM

- o Miscellaneous sump pumps

- 3 MLPs, pad A and B
- 22 pumps 31,730 GPM
- 14 motors 3,500 HP
- 8 diesels 4,850 HP
- 3 MLP's, Pad A & B
- 5 pumps 300 GPM
- 5 motors 104 HP

HEAVY EQUIPMENT

- o Heavy Equipment

- 342 Pieces of equipment,
including:
 - . 4 mobile cranes
 - . 9 aerial platforms
 - . 5 aircraft tugs
 - . 1 convoy commanders van

- o CLS Lifting Operations

- Contingency planning
- Tagline system
- 4 mobile cranes
- 4 high rangers
- forklifts

CT/MLP, PAD STRUCTURES

- o Rotating Service Structure (RSS) (2)

- 28 movable platforms
- Traction drive systems
 - 8 15 HP DC motors
- 2 movable platforms
- 1 lightning mast

- o Fixed Service Structure (FSS) (2)

- o Other pad structures (per pad)

- East stairtower
- West stairtower
- Pneumatic tower

- o MLP (3)

- 3 flip-up platforms
- 3 flip-up platforms
- 2 flip-up platforms
- Isolated floor
- Pressurized compartment doors
(52 per MLP)
- Sound suppression water bags
- Structural system
- 2 side flame deflectors
per pad (movable with
hydraulic jacking systems)
- 1 main flame deflector per pad
- 6 each at 6 locations
- 2 per pad
- 50 units
- 7 diesel engines totaling
8,200 HP
- 1,400 HP diesel engine
- Electronic, hydraulic, and
pneumatic systems

- o Flame deflectors

- o Mount mechanisms
- o Launch water holding tanks
- o Low level O₂ analyzers
- o Crawler Transporters (2)

- o SRM/MMSE Transporters (2)

CRANES, DOORS, PLATFORMS, ELEVATORS

- o Cranes and hoists
- o Mate demate devices at KSC and DFRF
- o Power doors
- o VAB and RPFS work platforms
- o OPF orbiter floor lifts
- o Elevators
- 115 devices from 1 to 250-ton capacity
- 55 roll-up
- 24 vertical lift
- 12 horizontal
- 462 platforms total, 236 power operated with remainder manual
- 3 per OPF bay
- 38 elevators from 3 floor office elevator to VAB and pad high rise elevators

COMPLEX CONTROL CENTER (CCC)

- 24 hr./day, 365 days/yr. remote monitoring: water, pneumatic, HVAC and electrical power systems; 9,428 data points

WORK CONTROL

- o Develop work control and accounting guidelines
- o Administer and monitor the implementation of work control instructions
- o Issue, track and status work authorization documents
- Enter tasks in AGOSS
- Prepare and distribute daily shop schedules, period and special reports
- Prepare and distribute special special WAD's for special

PLANNING AND SCHEDULING

- o Provide OMD support to facility O&M organizations
- o Operate real-time support and trouble call service
- o System outage and excavation permit processing
- o Support automated support requirements
- Technical writers prepare and maintain 500 OMI's and IDMM's
- 943 real-time requests and 717 trouble calls per month
- 188 outages per month
- 3-shift/7-day support required

MODIFICATION MANAGEMENT

- o Prepare launch equipment shop (LES) work packages
- o Provide engineering support for LES fabrication and installation activities
- o Provide management and engineering contractor activities
- 90+ mandatory return to flight modifications (\$15-20 Million)
- Continuous planning for corrosion control of numerous steel structures
- Manage "Call" construction contract

MECHANICAL SHOPS

- o Perform fabrication, modification, refurbishment repair and maintenance of C/T's, MLP's, PADS, OPF, VAB and other LC-39 facilities, systems and equipment
- o Perform sandblasting and painting of LC-39 facilities, systems, structures and GSE
- o Perform fabrication, modification, assembly and installation of pneumatic systems, panels and consoles, also including the testing of completed installations
- o Provide trouble call service and minor alterations, painting and repairs in SPC facilities. Minor moves of furniture and equipment are also provided.
- o Provide maintenance and repair of shops and labs, machinery and equipment.

ELECTRIC/ELECTRONIC SHOPS

- o Provide fabrication, modification, installation, repair and maintenance of LC-39 electrical systems and equipment, including cable fabrication and potting/molding of cables for logistics spares and LRU's.
- o Provide fabrication, assembly and testing of printed circuit boards, wire wrap board, electronic panels and chassis, as well as the maintenance of facility shops and lab's machinery control systems.

8.3.2 COMMUNICATIONS

COMMUNICATIONS

- o O&M, sustaining for voice comm, TV, data switching and transmission, timing and countdown, photo and cable plant
 - OIS
 - Special audio equipment (bridges, repeaters, amplifiers, etc.)
 - Astro comm
 - Secure communications network
 - Paging and areas warning system
 - Fixed radio networks
 - Shared radio networks (cranes)
 - 2676 units
 - 4112 units
 - Criticality 1 system
 - 51 areas in LC39 and industrial areas
 - 500 mobile, 800 portable, 40 fixed base stations and pocket pagers
 - 200 portable radios, 8 fixed based stations
- o Landing Site Communications
 - Dryden SLA - OIS, radio, audio recording, paging and area warning
 - CLS - portable satellite terminals, radio, voice communications, audio recording
 - Transportable comm. system - shipping container (40 ft. trailer), 3 fixed base radios, area paging, voice communication and audio recording.

- o Cable Plant
 - 1.5 billion conductor feet, 90 main distribution frames, 900 telephone cabinets
 - 40 miles of multi-strand fiber optics cable, and 20 terminal locations
 - 400 manholes and 48 miles of duct bank

COMMUNICATION DESIGN

- o Responsible for design of new communications elements or systems including:
 - Photo optics
 - Timing and countdown
 - Video systems
 - Fiber optics/wideband
 - Area page and warning
 - Secure communications
 - Voice systems
- o Develop/revise multi-year communications modernization plan
- o Perform design studies and develop candidate design concepts, provide engineering sketches, preliminary cost tradeoffs. Current examples include: Application of new concepts, OTV monitor of crawler transporter hydraulic and engine areas, high rate fiber optics system
- o Research vendors to identify and evaluate viable sources of state-of-the-art hardware
- o Develop specifications and purchase requests for new hardware.
- o Develop criteria and procedures for testing new hardware in support of communications systems
 - Coordinate activities areas organizations including Technicolor and RCA
 - Support/observe testing - generate test reports to document results
- o Lead and/or participate in review to select and finalize design approaches. Interface with NASA DE and TE
 - Provide detailed assessment of selected approaches. Develop costs and schedules. Coordinate with affected organization.
 - Finalize engineering sketches.
 - Release for drafting
- o Implement return to flight mods (post 51-L)
 - Emphasis on Pad B, MLP-1, LCC, and press site. Includes design and implementation of the film/video analysis laboratory.
 - Approximate 40 sub-tasks in photo-optics/TCD area, e.g., Goertz Tracker mod, camera housing and pedestal re-design.
 - Generate and release TCTI (75) packages. Generate supporting SR's as required. Provide facility requirements.
- o Update engineering documentation
 - Review and redline comm. system drawing to achieve an as-built baseline. Pad B photo optics/CDT encompasses 300 sheets to date.
 - Review OMRSD/PRD/PADD documents
 - Review and redline drawings to identify differences.
- o Complete Mod implementation for Pad A, MLP-2, 3
 - Generate TCTI's for implementing required updates to Pad A, MLP-2, 3

- o Update engineering operations manuals
 - Generate detailed reference drawings/charts for operational setup

OIS-D PROJECT

- o Design support to DE for development of the OIS-D. Lead design for end instruments and test boxes. System elements are:
 - Central Summing Network (CSN)
 - Test Control (TC)
 - End Instruments (EI)
 - Design and follow through of end instruments. Coordinate with production vendor. Follow changes.
 - Develop test procedures
 - Troubleshoot prototype LRU's/assemblies
 - Design test boxes for off-line maintenance
 - Support system test
- o Provide drafting effort
 - PC Board Layout (100)
 - Drawings (600 sheets)
- o Design software system including operating system, applications, and support software
 - Develop software requirements
 - Generate 30,600 lines of code
 - Modify/maintain code and documentation
- o Support installation and checkout
 - Support system integration
 - Develop and maintain maintenance manual

ELECTRONIC DEVELOPMENT LAB

- o Provide facility and expertise for prototyping hardware as well as for fabricating unique production hardware - limited quantity.
 - Engineering review of sketches and/or drawings
 - Generate parts lists. Identify substitutes
 - Varied tasks - some quick response. Current prototype work in-house is 5,000 m/hrs - production 19,000 m/hrs.
 - Provides production support including kitting of parts, preparation of purchase requests, maintaining bench stock.
 - Machine shop operation for prototyping.

COMMUNICATIONS DESIGN AND DEVELOPMENT

- o This is a post 51-L function for SPC, not previously in the contract. This work was previously performed by four different contractors: PRC, RS&H, PRC BRIEI and Boeing, under the direction of DE.

9.0 LOGISTICS

Materiel Control and Engineering; 51-L Headcount = 583

9.1 RESPONSIBILITY - Develop/acquire/manage the resources, including government-furnished property/equipment and flight hardware spare/repair parts, to assure timely and cost effective logistics support of KSC STS processing, launch, landing, and recovery activities. As one of the 12 major SPC elements, Logistics is presented herein in the following functional elements:

1. Director of Logistics
 - a. Property Administration
 2. Logistics Operations
 - a. Supply Support
 - b. Transportation
 3. Logistics Support
 - a. Logistics Engineering
 - b. Procurement
 - c. Technical Training
-

9.2 LOGISTICS FUNCTIONAL SUMMARY

1. PROPERTY ADMINISTRATION

2a. SUPPLY SUPPORT

- o Warehousing
- o Receiving
- o Issue
- o Kitting
- o Bench Stock & Tool Control
- o Custodial Storage

3a. LOGISTICS ENGINEERING

- o Provisioning, Research and Identification
- o Stock Control
- o Reparable Assets Management
- o Modification Assessment/Processing
- o Equipment Records
- o Product Support Management
 - Flight Systems
 - Ground Systems
- o Internal Audit & Inventory

2b. TRANSPORTATION

- o Freight Traffic
- o Packaging & Preservation
- o Delivery
- o Vehicle Operations
- o Travel
- o Transportation Coordination and Off-site Support

3b. PROCUREMENT

- o Administration
- o Procurement
- o Subcontract Management

3c. TECHNICAL TRAINING

- o Course Development
- o Instruction
- o Certification Program

9.3 51-L HEADCOUNT SUMMARY

The following 51-L headcount data were derived from comparison/extrapolation of the Bottoms-up Manpower Review, organization charts, and SPC personnel "pool identification by organization " tabulations.

o Director of Logistics	8
o Logistics Operations	1
- Supply Support	7
. Storage and Distribution	117
. Shuttle Process Support	140
. Logistics Support	
Ground Operations	34
- Transportation	65
o Logistics Support	4
- Logistics Engineering	4
. Inventory Management	33
. Logistics Engrg. Support	78
- Procurement	65
- Technical Training	27
Total	583

Average overtime was 13.9% during the period Nov/Dec 85 which yields an equivalent headcount of 664.

9.4 WORK VOLUME INDICATORS

1. Director of Logistics - Property Administration

Tasks: Provide management of the Logistics Directorate, Logistics Operations, and Logistics Support, including compliance with the overall logistics support plan, direct and control resources, operational analysis, budget, property administration/control/inventory, etc.

Work Volume Indicators: Unquantified except property administration; property control survey - CY87, 3 surveys/month of 34,000 equipment items and 145,000 material line items; property inventory - 11 custodian accounts and 2,551 items/month (one sample lot number represents 3,900 line items/month); property lost, damaged or destroyed reports - FY87 average 23 PLDD's valued at \$40,189/month.

2a. Logistics Operations - Supply Support

Tasks:

- | | |
|-----------------------------------|---|
| o Warehousing | o VAB High Bay II Support Operations |
| o Vehicle Processing Support Area | o Material Service Center (Operations) |
| o Receiving | o Material Service Center (Ground Ops.) |

Work Volume Indicators:

WAREHOUSING (April 87) - miniload operations - 7,100 line items issued (5.5 minutes/line item work standard); 3,034 line items binned (10 minutes/line item standard); pallet/cantilever/bulk/cable - 6,190 line items issued (20 minutes/line item); 2,440 line items binned (25 minutes/line item); mod kitting - unquantified; POL operation - 1,031 line items issued (15 minutes/line item); 2,000 line items binned (18 minutes/line item); vendor owned cylinder control-unquantified; central warehouse support - customer service-unquantified; KIMS/LASS terminal opers. - unquantified; unserviceable/excess/shelf-life - unquantified; bench stock - 70 locations, 7,300 line items replenished; custodial storage/excess - unquantified.

VEHICLE PROCESSING SUPPORT (APRIL 87) - Orbiter mod/flight kits; mission kits; hardware disposition area; computer terminal opers; flight spares warehousing/receiving - unquantified (work standards for all are 9.5 minutes/line item issued and 8.5 minutes/line item binned).

RECEIVING (APRIL 87) - Material receiving dock - 6,200 line items received; averaged 125 discrepant line items on hand; material in checking -unquantified; material/computer message match - unquantified (combined work standard for all receiving is 25 minutes/line item received).

VAB HIGH BAY II SUPPORT - Process PMR's for orbiter processing; receive/ store/ issue temporarily removed flight hardware; flight crew eqpt. opers; central tool control - all unquantified

MATERIAL SERVICE CENTERS (SHUTTLE PROCESSING) - MSC HMF; MSC's 28 and 29 (OPF bays 1 & 2); MSC 31 (OPF room 101); MSC 32 (VAB); MSC 35 (Pad A); MSC 36 (Pad B); MSC 44 (RPSF); MSC 55 (Hanger AP) - all unquantified. MSC'S provide:

- | | |
|---|----------------------------------|
| o GSE processing | o Unserviceable hardware process |
| o Support equipment move authorization (SEMA) | o Point of use storage |
| o Shelf-life control | o Return to stock |
| o Tool loan process | o Bench stock |
| o Process orbiter PMR's | o Tool cal control |
| o Receive/store/issue temporary removals | o Computer terminal opers. |
| o Tool, garment, equipment issue | o MERL & MICR kit process |
| o GSE receiving | o GSE reusable container control |
| | o Customer interface |
| | o Custodial account control |

MATERIAL SERVICE CENTER (GROUND OPERATIONS) - MSC 14 (Comm. support); MSC 37 (LES shop); MSC 39 (clean lab); MSC 40 (crawler); MSC 42 (heavy equipment) - all unquantified; same functions as above MSC's.

2b. Logistics Operations - Transportation

Tasks:

- | | |
|----------------------|---|
| o Freight traffic | o Vehicle Operations |
| o Packaging/shipping | o Travel |
| o Delivery | o Transport Coordination and offsite planning |

Work Volume Indicators:

FREIGHT TRAFFIC - bills of lading - approx. 700 documents/month; determine freight classification by material/condition - approx. 560 transactions/month; rating and routing by weight/size/destination/date/mode of travel - approx. 580 transactions/month; over/short/damaged - approx. 15 investigations/month; household goods - approx. 15 relocations/month.

PACKAGING/SHIPPING - packing and crating - 2,200 line items/month; preservation packaging - 1,230 line items/month; special container fab. - average 160/month; shipping - 2,200 line items/month; load/block/brace - 5 shipments/month; packaging engrg/spec control - 160 items/month; hazardous material - 10 shipments/month

DELIVERY - 400 delivery codes in KIMS; 258,000 driver miles annually; 240 off-center trips/year; warehouse - 22,500 deliveries/month; air directs - 800 deliveries/month; fast freight and redistribution - 1,600 actions/month; red gloves (astronaut equipment) - 8 moves, 2 hours ea./launch

VEHICLE OPERATIONS - 495 vehicles of all types in operation; vehicle coordination service calls, DRL 042 plan, monitor usage (all unquantified)

TRAVEL - 250 passengers/month; 525 passports on file; ticket issue, foreign clearance guide, special projects, (all unquantified)

TRANSPORTATION COORDINATION AND OFF-SITE PLANNING - SRM rail shipping, ET barge, LOGAIR flights, contingency landing sites, DRL 043 off-site transport plan, (all unquantified).

3a. Logistics Support - Logistics Engineering

Tasks:

- | | |
|--|--------------------------------------|
| o Provisioning research and identification | o Modification assessment/processing |
| o Stock control/inventory management | o Product support management |
| o Repairable asset management | o Internal audit and inventory |
| | o Equipment records |

Work Volume Indicators:

PROVISIONING RESEARCH AND IDENTIFICATION - descriptive cataloging data - 1,668 line items/month; cataloging and record maintenance of flight components - 125 new records/month; catalog maintenance - catalog and KIMS updates - 774 line items reviewed monthly; ALERT processing - 26 packages processed/month; nonstock purchase request - 1,172 PR's processed/month; KIMS data entries - 5,698 transactions/month; research (procurement and QA discrepancies) - 1,083 telephone calls/month, 108 discrepant PR's resolved monthly; mod kit processing (identify stocked material, prep SR's and PR's) - 336 new line items processed/month; maintain log engineering library - unquantified.

STOCK CONTROL/INVENTORY MANAGEMENT - Replenishment - 2,250 requisitions/month; KIMS control - 4,500 transactions input/week, QRP processing 4 to 5/week; replenishment for reparable program 700 actions/month; inventory control point (ICP) management - 2,850 line items in inventory to preclude work stoppage (KC fitting, butt weld fittings, stainless tubing, pyro connectors, etc.); data base management - KIMS records, unquantified; work control (processing/keyboarding) - 1,200 transactions to ADP/month, 20 types of reports weekly/monthly/quarterly; special projects analysis - unquantified.

REPARABLE ASSET MANAGEMENT - due in repair (DIR) - 695 open line items/day, 43.4 line items/hour, DIR resolution requiring secondary support - 22%; due in exchange (DIX) - 348 open line items/day, 43.5/hour, problem resolution requiring other support - 85%; due in contractor (DIC) - 334 line items/day, 41.8/hour, problem resolution requiring other support 54%; flight hardware tracking (DIX) - 366 line items/month, (DIC) activity 304/month; operational logistics system (OLS) maintenance, management, and control (MMACS) - 6,427 line items/month, 140 line item problems/anomalies per month.

EQUIPMENT RECORDS - log, screen, research, tag new controlled property - 507 line items/month; establish/determine controlled property custodial accounts - 396 line items/month (req. form 29-101), NEMS nomenclature assignment 400 line items/month, complete document data into NEMS 563 line items/month; NEMS data input - 2,083 line items/month; item excessing - 700 line items/month; inventory support - 464 line items/month; review, validate, prep form 1018 government owned/contractor property - 2,083 line items/month; loan/NASA transfer coordinator - 150 transfer actions/month, new equipment 150 line items/month, suspense file 507/month.

MODIFICATION ASSESSMENT/PROCESSING - log mod management - 1,380 active projects (138 projects/PSM); material equipment requirements lists (MERL) - 98 STS-26R mandatory mods, 32 highly desirable return to flight mods, 1,250 non-STs mods; (estimated 2,760 TCTI's - all projects); initial provisioning/reprovisioning - 610 packages to be reviewed (100-120 hrs/pkg); material excess review - 5,200 line items/year (1 hr/item); project breakout (high cost items eliminate sole source) - 900 items/year (4 hrs/item).

PRODUCT SUPPORT MANAGEMENT - (FLIGHT SYSTEMS) - coordinate resolution of all open logistics requirements/work arounds/substitutions, etc. - unquantified; **(GROUND SYSTEMS)** 22 station sets require sustained coverage.

INTERNAL AUDIT AND INVENTORY - 2 internal audits/month; monthly inventory of 7 custodial accounts (1000 line items of equipment); one sample inventory of material in all storage locations triannually; 10 warehouse anomalies/day to reconcile shortages, incorrect storage, or overages; ADP systems (KIMS, OLS/MMACS, ADABAS, LASS, SPDMS) - 4 ESR's/month (8 manhours/ESR), 15 UPR/PRACAs/month (2 manhours each), 2 major design revisions/month (4 manhours/review), major data conversions (30 manhours/conversion).

3b. Logistics Support - Procurement

Tasks:

- o Purchasing
- o Subcontracts
- o Administration

Work Volume Indicators:

PURCHASING - procure supplies, materials and equipment - approximately 258 PR's with 632 line items/week; purchase order changes - 20 change orders/week.

SUB CONTRACTS - 40 purchase orders for supplies, materials, equipment and services (100 line items)/week; develop socio-economic program - small business subcontract goal (FY87) 45% of total; small disadvantaged subcontract goal 7% of total.

ADMINISTRATION - purchase request/purchase order data entry - 2,994 line items/month (FY87); PR/PO inquiries - 1,173 PO's/month (valued at \$3.0M); PR/PO breakdown and distribution - 300 PO's (732 line items)/week; screen non-stock PR's - 800 line items/week; resolve, process report deficiencies - 30/week processed; prep and process shipping documents (DD Form 1149) - 10/week; vendor validation - 7,200 active vendors on file; courier services - 760 documents delivered to O&C/Titusville weekly; vendor finance and procurement questionnaires - 75 to 80 new vendors added each month.

3c. Logistics Support - Technical Training

Tasks:

- o Course development
- o Instruction
- o Certification program
- o Special projects

Work Volume Indicators:

COURSE DEVELOPMENT - new courses requested - 23/month; analyze requirement; assign instructors, determine format, evaluate instruction, (all unquantified)

INSTRUCTION - skill courses - 400 students/month; safety/area access ~1,878 students/month; systems instruction - 895 students/month; computer instruction 2 each 12-hr. classes (1,500 students identified for training; 10 each/class maximum); training format - lecture or lab, 197 courses; interactive video, 37 courses; video presentations, 41 courses; OJT packages, 253 implemented.

CERTIFICATION PROGRAM - technical training - 287 formal certifications (44% of SPC workforce require cert/recert); employee participation - 2,423 SPC employees with cert cards; 11,695 active certs; 980 certs processed April 87; 1,929 cert cards issued/reissued in April 87; growth - 11,695 active certs expected to grow to 14,880 by September 88.

SPECIAL PROJECTS - NASA personnel training - 450/month; new hire/rehire training - 71/month; NASA and element contractors review/approve SPC courses - 75 courses/month.

10.0 LCC OPERATIONS

Test Support Management and LCC Operations; 51-L Headcount = 362

10.1 RESPONSIBILITY - This section includes LCC Operations, and the Test Support Management Office. These units provide managerial leadership to the SPC test team for all shuttle flight element processing. This includes all operations requiring LCC firing room support and control, including operational floor support to VAB and pads A and B through operations engineers, site test conductors and pad leaders. The organizational structure shown is post 51-L, but represents essentially the same work scope and headcount known previously as LCC Operations, and Program Planning and Control (PP&C).

LCC OPERATIONS

These elements operate primarily from the Launch Control Center (LCC) and consist of the following:

LCC Operations Director - The LCC directorate is composed of two distinct line organizations and a technical administrative staff.

- o Test Operations
 - Lockheed Test Directors (LTD)
 - Orbiter Test Conductor (OTC)
 - Tank/Booster Test Conductor (TBC)
 - Cargo/OMI Integration
 - Flow/Site Operations (STC's)
 - Test Team Training
- o Test Services
 - Computer Support
 - Vehicle Integration Test Team (VITT) Support
 - Operations Center Support
 - LCC Facilities

TEST SUPPORT MANAGEMENT

The Test Support Management Office is responsible for commitment and coordination of Support Operations resources such as HVAC/ECS, power, water, pneumatics, heavy equipment, cranes/doors/platforms/elevators, launch equipment shop, life support, C/Ts, MLPs, calibration, chem lab., etc. The department is composed of two offices:

- o Test Support Operations
 - Support Test Managers
 - Support Operations Duty Officers
 - Site Management
- o Test Support Planning
 - Procedures
 - Special Reports

10.2 51-L HEADCOUNT SUMMARY

LCC OPERATIONS

o Operations Control Dir. & staff	11
o LCC Operations Management	2
- Test Operations	49
- Test Services	19
o Operations Planning and Control	6
o Flow Management, OV-101,2,3,4	6
o Orbiter Planning and Scheduling Mgmt.	2
- Flow Planning	15
- Orbiter Flow Processing	43
o Site Planning and Scheduling	49
o Integrated Operations	14
o O&M Documentation Mgmt.	3
- Planning	22
- Production	57
o Shuttle Work Control	29
Subtotal	<u>327</u>

TEST SUPPORT MANAGEMENT

o Test Support Mgmt	4
- Support Test Managers	8
- Support Ops. Duty Officers	5
- Site Management	8
- Requirements	2
- Procedures	6
- Special Projects	2
Subtotal	<u>35</u>

TOTAL LCC OPS AND TEST SUPPORT MGMT. 362

Note: Overtime data not included in references.

10.3 WORK VOLUME INDICATORS

10.3.1 LCC OPERATIONS

LOCKHEED TEST DIRECTOR (LTD)

Lockheed Test Directors support all LC-39 operations 24 hr/7 day/wk to coordinate resource prioritization, direction of emergency operations and SPC managerial presence. During primary flow integrated testing, the LTD staff a second firing room to coordinate operations not associated with the prime test in progress.

- o Overall Control of SPC launch complex 39 testing - realtime
- o Resolves SPC resource priorities realtime
- o Responsible for SPC test team discipline
- o Responsible for hazardous operations control
- o In charge during declared emergencies

10.3.1 LOCKHEED TEST DIRECTOR (Continued)

- o Office or prime responsibility for emergency procedures documents
- o Single point of contact between test team and outside agencies for SPC testing - 7 days/week 24 hours/day
- o Chairs 0730 shuttle status meeting
- o Chairs white phone call - 5 days per week
- o Provides SPC management presence - 7 days/week 24 hrs/day
- o Authorizes overtime realtime for all SPC organizations
- o Concurs in any milestone schedule change
- o Concurs in any realtime schedule change
- o Supports schedule meetings - 25 weekly meetings
- o Chairs all formal integrated pre & post test briefings - 25 per flow
- o Monitors certification of all firing room test team personnel - 500 engineers per year
- o Arranges & coordinates test team training exercises (i.e., countdowns, emergency egress, etc.). Approximately 12 integrated SIMS per flow and 100 single system SIMS per flow.

TEST TEAM TRAINING

Develop training aids and scheduling of test conductor and all test team members for firing room training and certification.

- o Prepare monthly training schedule for test operations and test services
 - Classes for certification
 - Retrain/Recertification
 - Safety Classes
 - Security Training

ORBITER TEST CONDUCTOR

Orbiter test conductors direct and coordinate all power-up orbiter testing three shifts per day, six days per week. They coordinate, write, conduct all integrated OMI's including launch countdown.

- o Responsible for all integrated test planning and on-station performance of integrated testing.
- o Responsible for implementing daily test schedule
- o Establishes OIS and call sign requirements
- o Participated in standboards - for 500+ engineers being recertified

ORBITER TEST CONDUCTOR (Continued)

- o Responsible for SPC formal integration pre and post test briefings - 20 briefings per flow.
- o Ensures safe conduct of test activities
- o Responsible for integrated open item reviews
 - 20 OIRS/Flow - Manual review of 1100 page document
- o Prepares and participates in flight crew briefings
- o Responsible for staffing firing rooms
 - All vehicle power-on testing - 3 shifts per day - 6 days per week times four orbiters: approx. 250 OMI's.

TANK/BOOSTER TEST CONDUCTORS

TBC'S are responsible for all power-up testing on the SRB and external tank from start of buildup through launch. They support integrated testing 3 shifts/day, 6 days/week.

- o Responsible for supporting all ET/SRB tests - 100 power up tests per flow
- o Participates in MTI schedule meetings - 20 per week
- o Responsible for all ET/SRB integrated test planning and on-station performance of integrated testing
- o Responsible for implementing daily ET/SRB test schedule
- o Participates in ET/SRB function standboards
- o Responsible for formal integrated ET/SRB related pre and post test briefings - 25 per flow
- o Ensures safe conduct of ET/SRB test activities.

CARGO/OMI INTEGRATION

The Cargo/OMI integration group is a dedicated core of OTC's assigned to maintain OMI standards for all integrated procedures. In addition, they are responsible for writing and conducting six cargo oriented OMIs per flow. They are also responsible to coordinate changes associated with cargo unique items, modification items, and mission peculiar items with the other OTC OMI OPR's.

- o Responsible for scheduling, developing and stabilizing integrated OMIs and bar charts - 50 OMIs per flow.
- o Approves all OMI ICRs - 300 OMIs per flow (historical data)
- o Co-chairman of the ICR control board - one meeting per week.
- o Responsible for integrating payload into LC39 facilities including firing room support for OMI/test performance.

CARGO/OMI INTEGRATION (Continued)

- o Chairs OMI/OMISS Change Control Boards.
- o Responsible for DOD and NASA payload and integration into LC39 facilities including firing room support for OMI/test performance - 6 OMI's per flow.

FLOW/SITE OPERATIONS (STC's)

The STC's are responsible for realtime schedule implementation. They support the VAB and Pad A and B sites, as well as the shuttle when it is resident in a particular site. They act as liaison between the LTD/OTC/TBC and tech operations to resolve realtime work stoppages.

- o Site Test Conductors
- o Pad Leaders
- o Vehicle operation
- o Responsible for staffing pad leaders and vehicle operations flow
 - 3 per day/6 per week ... 4 veh/2 pads and VAB
- o Responsible for implementing GSE and facilities schedule.
- o Work with shop and planning and scheduling to set priorities to ensure GSE and facilities support daily schedule.
- o Function as part of flow operations when vehicle or flight hardware on site, when no vehicle on site will man desk for site control.
- o Coordinates daily operations on-site emergencies
- o Responsible for implementing daily schedule, or know why items not accomplished.
 - Responsible for manning the OPF desk - OPF, VAB, Pads
 - 6 days per week/3 shifts
 - Constant contact with TC/LTD on OIS
 - Attends and inputs to daily integrated schedule meeting
 - 3 per day
 - Polices open WADs to encourage closure
 - Attends OIRs
 - 250 per flow
 - Move with vehicle
 - Coordinates red/contingency crews
 - Participates in impact assessments
 - for each modification
 - Provides test conductor for vehicle mate and demate operations
 - Responsible for ET/SRB operations

TEST SERVICES

Test Services perform a variety of tasks for SPC. The primary task is to staff the SPC/NASA realtime schedule and emergency information distribution center to provide management with up-to-date process information 24 hours per day, 7 days per week. They also prepare and support management reports, including parts of the daily schedule. The astronaut office is supported by test services personnel. Test services also reviews, approves, and tracks all LCC facility modifications. Documents major milestone reviews: launch readiness reviews, test readiness reviews, payload readiness reviews, OPF/VAB rollout readiness reviews, vehicle status internal reviews and KICS internal performance reviews.

o Computer Support

- Launch/Flight Readiness Reviews (LRR/FRR)
- Level II Test Readiness Review (TRR) NASA/contractor management, as scheduled
- Payload readiness reviews NASA/contractor management - as scheduled
- OPF/VAB rollout readiness reviews NASA/contractor management - as scheduled
- Vehicle status internal reviews (pipe line) NASA/LSOC Sr. Management - monthly
- KICS internal performance reviews for director, KSC Operations/Sr. Management - daily

VEHICLE INTEGRATION TEST TEAM (VITT)

The VITT organization provides coordinating and integrating support to JSC's VITT and the astronaut offices. They disposition and sign PR's in this support function.

o Overview

- The LSOC Vehicle Integration Test Team (VITT) provides engineering support to the JSC VITT and astronaut offices
 - 5 to 7 days/1 to 3 shifts pending demand

o Engineering support

- Provides daily verbal and weekly written orbiter processing status to the JSC VITT and astronaut offices.
- Follow orbiter modifications, testing, system troubleshooting, problem resolution.
- Act as crew representative in sign-off inflight anomalies and IPR's and PR's requiring crew cognizance.
- Represent flight crew(s) and other JSC elements in OMI and procedure reviews that affect them.
- Monitor tests in which flight crew participates
- Configure the orbiter crew compartment with mission specific items as requested by the flight crew.
- Submit JSC switch list inputs for S0017 TCDT and S0007 launch countdown
- Coordinate astrovan activity for KSC landing operations
- Monitor status of astronaut training required by KSC for TCDT and launch operations and arranges KSC training classes as required.
- Provides logistical support for operation of astronaut office and crew quarters
- Tracks/records KSC astronaut office and crew quarters expenditure of JSC funds used for items not supplied by KSC
- Acts for astronaut office and crew quarters manager during periods when manager is absent
- Provides personal and administrative support for astronaut crews during TCDT and launch and landing operations

OPERATIONS MANAGEMENT CENTER

This is the one LC-39 single location which keeps up to date status and information with respect to all LC-390 processing. This frees on-net personnel from these responsibilities. This station is on duty 24 hours per day/7 days per week.

- o Maintains/reports status
 - Monitors and statuses integrated test via OIS, OTV, and telephones
 - Provides near realtime status of shuttle processing
 - Updates status telephone recording each shift
 - Develops and distributes daily log summary - daily
 - Maintains status of KICS work items - information obtained from scheduling meeting/telecons
 - Produces daily report of schedule versus schedule accomplishment for management visibility
 - Coordinate/maintain during launch countdown
 - Constraints list
 - OMI status
 - Red crew list
 - Manager on call
- o Support Problem Resolution
 - Obtains information about problems - notifies proper management - uses an approved call matrix
 - Notifies management of emergencies and medical incidents
 - Notifies management of flight vehicle and facility damage
 - Provides capability to locate necessary personnel (on the job..at home)
 - During countdown, be a crisis management center
 - Hosts assigned senior manager, prime board meetings, special management meetings and Red crew
 - Designated as the SPC/TP Hurricane Center
- o Supports Maintenance of Security
 - Provides temporary (24-hr) badges for secure firing rooms (3 & 4)
 - 3 shifts per day/7 days per week
 - Controls secure and non-secure conference rooms
- o Computer system support
 - Compiles daily log summary of operations
 - Capability to access training certification records
 - Planned capability to access BOC clearance records

LCC FACILITY ACTIVITIES

This group monitors, coordinates and reviews all LCC facility modifications and changes under the cognizance of the SPC. It also provides LCC safety committee forum, emergency preparedness coordination, and NRP planning.

- o Participate in modification meetings
- o Develop ESR's/SR's to meet security safety, and operational requirements
- o Maintain and reproduce site plans for management
- o Develop area utilization plans to place equipment services, and desks to maximum utility

LCC FACILITY ACTIVITIES (Continued)

- o Perform hurricane prep walkdowns
- o Integrated support functions
 - Chair daily LCC integrated support meeting (daily)
 - Review status of modifications, outages, tests, etc., and reschedule when necessary
- o Ground systems review functions
 - Chair LCC Site Team (B-9) review meetings
 - Review systems criticality
 - Recommend changes or updates to LCC systems as required
 - Close hazard reports or ensure hazards are being corrected
- o National Resource Protection Activities
 - Review National Resource Protection Plan (NRP)
 - Develop and propose LCC operational areas security requirements
 - Prepare requirements for card readers & cypher locks
- o Safety responsibilities
 - Develop and implement LCC safety program
 - Chair LCC safety Committee (general) meetings
 - Perform and report safety/housekeeping inspections (weekly)
 - Initiate actions to resolve safety/housekeeping problems.
 - Reviews "Alerts" and "Safety Alerts" for impacts and report results
- o Emergency preparedness coordination
 - Review and provide comments to emergency preparedness plans
 - Develop plans and requirements to use OMC as the SPC operations hurricane center

10.3.2 TEST SUPPORT MANAGEMENT

TEST SUPPORT MANAGEMENT OFFICE

Provide managerial leadership to the support operations test team for all ground support and flight element processing requiring LCC, CCC and site coordination.

- o Responsible for implementing the LSOC support Operations Test Director function.

TEST SUPPORT OPERATIONS

- o Support Test Managers
 - Responsible for the overall support and coordination of LSOC support ops resources during testing.
 - Provide the single point contact for notification of anomalies
 - Coordinate personnel and resources during test operations
 - Provide status presentations at test briefings and coordination meetings.
 - Provide readiness briefings and certifications for milestone events.

TEST SUPPORT OPERATIONS (Continued)

Manpower for this is driven by manning 2 firing rooms, 2 men per console 7 days/3 shifts operation.

- Provide console manning in the support of over 400 operations and maintenance documents.
- Daily participation in SPC meetings: Collective decision makers, coordinating/integrating resources
- TSMO is a supporting organization with the main driver being the SPC "KICS" schedule.

SUPPORT OPERATIONS DUTY OFFICER

Manpower for this function is based on a 7 day/3 shifts operation. The consoles located in the CCC must be manned 24 hours a day/7 days a week and holidays.

- o Coordinate realtime requests and schedule changes for LSOC comm, Technicolor, janitorial, EG&G, BIO, Wiltech and PAA support at CCAFS.
- o Open, close and coordinate support for all approved outages on facility O&M systems.
- o Assist in coordinating all support for overhead cranes in VAB, OPF, Pads A&B, and surge facilities: powered doors, elevators, H/E, adjustable platforms and facility maintenance personnel and high crew.
- o Realtime scheduling
- o Single point contact for anomalies and emergencies

SUPPORT OPERATIONS SITE MANAGEMENT

Manpower for this function is driven by 5 days/1 shift operations. Responsible to provide overall coordination for support operations directorate at assigned site. Work closely with integrated operations teams to ensure compliances with program requirements. Is the single point of authority for commitment of support operations resources within assigned site.

- o Single point of contact between NASA/LSOC organizations
- o Develop, implement and update master schedules
- o Review and coordinate outages with NASA and other contractors
- o Review, update and maintain the daily integrated scheduling meeting (KICS)
- o Sites - VAB, OPF, MLP's, Pads A and B, HMF/ LETF/ O&C, LCC/ SLF, OMRP and RPSF
 - Daily participation in SPC meetings
 - Coordination of all support functions: HVAC, power, water, pneumatics, H/E, cranes/doors/platforms/elevators, LES shops, USI, WTI, GTSI, and LCOM.

TEST SUPPORT PLANNING

Manpower for this function is based on a 5 days/1 shift operation. They participate with NASA and other contractor elements to coordinate the utilization of equipment, facilities, systems and other resources for operations in support of launch/test and site operations. Included is the maintenance/update of 400 OMI's. They are the office of prime responsibility for 23 of these documents.

- o Prepare integrated operations and maintenance instructions (IOMI's) supporting each major test/event on the master STS processing schedule.

SPECIAL REPORTS

Manpower for this function is based on a 5 day/1 shift with support for Saturday/Sunday as required. Responsible for attending various meetings on a weekly basis and preparing the necessary management reports to provide visibility of special activities within the test support management office. Including:

- o Establish hardware and software requirements for TSMO participation in automated data processing effort.
- o Represent TSMO on the Support Operations Computer System Steering (SOCS) Committee
- o Represent TSMO on the Automated Ground Operations Scheduling System II Integrity Committee.
- o Represent TSMO on the System Integrity Assurance Program Plan (SIAPP) Committee.
- o Develop local area networking system for TSMO
- o The development of computer networking for TSMO
- o Status reporting of over 400 GSE open items
- o Preparing and tracking ESR's
- o Analyze and report on monthly MIC reports and provide vans to project controls
- o Assist TSMO management in accessing department workload and assignments
- o Perform weekly audit of time, labor charges, and work authorization.

MEETINGS ATTENDED BY LCC OPERATIONS AND TEST SUPPORT MANAGEMENT PERSONNEL

- 0730 Sched. Mtg. (KICS)
- 0800 Telecon (White Phone)
- 0815 Directors Mtg. (Ops. Ctr.)
- 1300 Level II Meeting
- 1400 Schedule Meeting
- Wednesday Assessment Meeting
- Tuesday long and near term program assessment
- All pretest briefings in LCC
- All development meetings for SIMS runs
- All Special Meetings for problem solution and special scheduling requirements (outages, special tasks, etc.)
- Some site schedule meetings for operations that affect FR participation
- All daily site schedule meetings and weekly mod meetings
- Shuttle Operations Working Group three times a month
- Pipeline - monthly
- 0700 KICS Review, Ding sheet problems, etc.
- 0830 NASA site Rep. Meetings (outages, construction, KICs, etc.)
- 0900 OV-103 Vehicle Meeting
- 0945 OV-104 Vehicle Meeting
- 1030 OV-102 Vehicle Meeting
- Management Safety Committee Meeting
- Ops Review Board
- All Special Meetings

11.0 OPERATIONS

Orbiter Processing O&M; 51-L Headcount = 1025

11.1 RESPONSIBILITY - The broad title of "Operations" herein encompasses SPC responsibilities within the following functional organizations:

- o Shops/Processing Contractors Directorate
- o Orbiter Processing Facility (OPF)
- o Pad Operations
- o Offsite and Contingency Landings

These SPC shops/processing elements provide site operations and maintenance at the OPF, HMF, VAB, Pads A & B, SLP, and remote landing sites such as DFRP, White Sands Space Harbor, Spain, Africa, et al. Those elements are generally responsible to:

- o Process orbiter from landing and recovery worldwide, to launch
- o Monitor direction of all orbiter stand-alone operations
- o Monitor performance of all SRB and ET stand-alone assembly
- o Support orbiter, GSE and site modifications.

Each element, more specifically, is responsible as follows:

SHOPS/PROCESSING SUBCONTRACTORS - Direct operation of all facilities and technician personnel required to process the space shuttle transportation system at KSC from landing and recovery worldwide, to launch, including integration of Rocketdyne SSME maintenance and Morton Thiokol SRB/ET assembly support into the SPC.

ORBITER PROCESSING FACILITY - Manage and staff the OPF, HMF, VAB shops and labs, TPS operations groups, GSE, and industrial shops with the prime scope of orbiter maintenance. This element provides:

- o Site and facility manpower for the above
- o Training, certification and safety for the OPF
- o Human and budgetary controls for the OPF site
- o Functional line management to departmental levels of four divisions
 - OPF Bay 1
 - OPF Bay 2
 - GSE and industrial shops
 - TPS operations

PAD OPERATIONS - Provide the necessary personnel and resources to maintain and validate systems and facilities for mating the orbiter vehicle to the assembled ET/SRB assembly, performance of integrated testing, transfer of the integrated vehicle to the launch pad, pad validations, payload transfer to the orbiter payload bay, fuel system servicing, ordnance installation, terminal countdown demonstration test, and countdown to launch.

Pad operations has overall responsibility for processing the space shuttle system after orbiter arrival in the VAB for mating. Launch pads, 39 A & B, and MLP's 1,2, & 3, including safety and housekeeping, are a part of this responsibility.

OFFSITE AND CONTINGENCY LANDINGS -

- o Develop and maintain all documentation associated with offsite landing sites including such items as:
 - Site survey reports and implementation plans
 - Operations and modification plans
 - Convoy operations plans and schedules
 - O&M instructions
 - Personnel requirements
- o Maintain and control orbiter GSE for:
 - Landing aids and deservicing
 - Convoy and turnaround operations
 - SCA mate and ferry operations
 - Orbiter demate and tow to OPF
- o Operational responsibilities such as:
 - Convoy readiness
 - Crew egress/rescue operations
 - Orbiter mate/demate/tow operations

SSME - Rocketdyne is sub-contracted (NAS10-10900) to the Lockheed Space Operations Company at KSC to perform the "Hands-On" processing of the SSME. SSME processing operations include the general disciplines of:

- o Systems Engineering
- o Quality Engineering
- o Elec. & Mechanical Technicians
- o Q.C. Technicians
- o Configuration Management
- o Safety
- o Clerical Support
- o Management
- o Logistics
- o (Total of 74 people)

These various personnel perform all the maintenance, refurbishment, modification, installation/removal and off-line checkout of the SSME's and all associated GSE. In addition to the actual hands-on work, Rocketdyne also writes all of the SSME Processing OMI's PMOMI's, TPS's etc. All SSME related problems are dispositioned by Rocketdyne. Rocketdyne coordinates all of its efforts with the NASA and LSOC/SPC responsible disciplines.

Rocketdyne is also under contract to MSFC (NAS8-27980) to provide SSME Launch Support Services (LSS) at KSC. 15 personnel perform the design center coordination efforts between KSC, MSFC and Rocketdyne at Canoga Park.

- o Design Liaison
- o Change and Requirements Integration

11.2 51-L HEADCOUNT SUMMARY

The following headcount data were reconstructed from the Bottoms-up Manpower Review, organization charts, and personnel pool identification tabulations. It is known that contingency landing scope and manpower have escalated since 51-L ground operations, but efforts to precisely define the headcount increase were unsuccessful. Any decrease in the headcount shown for CLS should be reassigned within the Operations elements shown.

OVERALL HEADCOUNT

o Shops/Processing Contractors Directorate	8
o Orbiter Processing Facility	514
o Pad Operations	410
o Offsite and Contingency Landings	93
KSC Total:	<u>1025</u>
o Rocketdyne SSME processing and launch support services (KSC contract)	74
Orbiter O&M effective total KSC HC	<u>1099</u>

This does not include 154 Rockwell techs on special assignment as of 6/87. "Special assignments" have been a repetitive management tool during the program.

OPERATIONS ELEMENTS HEADCOUNT

o SHOPS/PROCESSING CONTRACTORS DIRECTORATE	8
o ORBITER PROCESSING FACILITY (514)	
- HB1 operations	85
- HB2 operations	84
- OPF GSE shops	95
- TPS	82
- Administration	25
- Access control	33
- HMF	27
- VAB shops	39
- OMRF	44
o PAD OPERATIONS (410)	
- Management/Administration	9
- Pads A & B	240
- MLP 1,2,3	76
- Flight systems (ET/SRB/ORB)	85
o OFFSITE AND CONTINGENCY LANDINGS (93)	
- KSC	35
- DFRF	42
- WSSH	1
- TAL	15
KSC Total:	<u>1025</u>
o Rocketdyne SSME maintenance/services	74
Orbiter O&M effective total HC:	<u>1099</u>

-Note: Overtime data not included in references. The principal investigator has witnessed 'hands-on' engineering, craft, and supervisory overtime at 30 to 40% for the two week period prior to each launch.

11.3 TASKS AND WORK VOLUME INDICATORS

SHOPS/PROCESSING SUBCONTRACTORS

Element tasks: Management of processing/launch and landings; direct operation of facilities and personnel; integrate Rocketdyne SSME maintenance and Morton Thiokol ET/SRB processing subcontractors within SPC; administrative support to LSOC engineering and shops; (1025 LSOC, 89 Rocketdyne, 341 Morton Thiokol personnel). Thiokol headcount addressed in subsequent section.

ORBITER PROCESSING FACILITY

OPF GSE SHOPS - Maintain, certify, and repair GSE, fixed platforms, stands, hydraulic supplies, hypergol systems, mass spectrometers, rolling GSE. Support orbiter testing per KICS schedule and OMI's. Repetitive GSE maintenance, calibrations, validations. Comm. and tracking lab operate radars, inertial tracking systems. Operate ECS and portable purge units. Contamination control. Sampling for OPF, VAB, HMF and pad operations.

Manpower divided 60%/40% was: orbiter direct support/GSE maintenance. Average per month: 256 PRs, 200 GSE WADs.

TPS - Maintain all orbiter TPS (tile, FRSI, external blankets, thermal barriers); repair flight and ground damage; support orbiter MCRs/perform TPS MCRs'; operate mix crib; perform offsite TPS ops; support OMI, IPR testing as required.

ACCESS CONTROL - Orbiter high bays manned with 3 crews (forward, mid, aft). In larger flows with horizontal payload installation in the OPF, 2 mid-body crews are required. Access control is required by contract; 1 orbiter integrity clerk each forward, mid, and aft compartment per shift; plus additional clerk per shift for relief. Access control required for maintenance and repair of orbiter structure, TPS, functional systems modifications, PLB configure, testing OMIs/IPRs, welding and brazing, security control. All unquantified.

HMF - Operate hypergol maintenance facility; process and repair FRCS an OMS pods; certified repair facility for all hyper QDs; O&M GSE at HMF; operate ordnance lab; operate LiOH lab; perform astro arc welding for all KSC. All unquantified.

VAB SHOPS - O&M flight crew equipment; O&M flight kits/cargo labs; optics lab (orbiter, ET, SRB, stack); wheel and tire shop (assemble, test, certify main and nose landing gear); clean room (servicing water canisters, window desiccant); flight and GSE battery labs (repair and service); harness and cable lab (service and certify); Kennedy avionics test set (KATS) maintenance and repair; refrigeration lab (particle refrigeration units at pads, MLPs, HMF, OPF, and landing facilities). All unquantified.

WAD'S FOR TYPICAL MISSION
"STS-30" OV-099 FLT 9

MISSION TIMESPAN	AUG. 11, 1985	THRU	OCT. 30, 1985			
	(A)	(B)	(C)	(D)	(E)	(F)
	AVG. NO. PER FLOW	AVG. REV. PER FLOW	AVG. PGS. PER DOC	** TOTAL PAGES	AVG. NO. COPIES	*** TOTAL DIST. PAGES
FLIGHT OMI'S*	513	195	210	148,680	95	14,124,600
FACILITY O&M OMI'S	215	N/A	43	9,245	25	231,125
JOB CARDS*	682	628	7	9,170	35	320,950
PROBLEM REPORTS	1250	N/A	15	18,750	N/A	18,750
TEST PREPARATION SHEETS	339	N/A	46	15,594	N/A	15,594
TOTALS	<u>2,999</u>	<u>823</u>	<u>321</u>	<u>201,439</u>	<u>155</u>	<u>14,711,019</u>
PLUS SCRUB TURNAROUND						4,300
						<u>14,715,319</u>

* SCRUB TURNAROUND AVERAGE REISSUE PAGES = 4,300
 ** A + B X C = D
 *** D X E = F

TYPICAL TPS WAD WORK/FLOW

o Tiles replaced	250
o FIBs replaced	30
o Gap fillers replaced	550
o PRs worked	850
o DRs worked	200
o PCR data sheets	2,900
o OMIs	7

NUMBER OF GSE PR's BY WORK AREA PER MONTH

YR	MONTH	OPF	OPF-1	OPF2	HMF	SLF	VAB
85	SEP	2	28	34	6	9	8
	OCT	0	39	16	2	8	18
	NOV	4	43	35	21	4	20
	DEC	5	33	22	9	5	16
86	JAN	2	27	57	19	6	15

YR	MONTH	MLP-1	MLP-2	MLP-3	PAD-A	PAD-B*	TOTAL
85	SEP	9	8	-	86	165	355
	OCT	16	23	-	80	132	334
	NOV	23	23	-	104	163	440
	DEC	9	16	-	58	105	278
86	JAN	22	5	-	48	179	380

Activation of MLP-3 began March 86. PR's March 86 through Feb. 87 totalled 192.

* 51-L launch pad

11.4 FUNCTIONAL BREAKDOWN AND HEADCOUNT

11.4.1 PAD OPERATIONS

51-L Headcount = 240

PADS A & B - Pad systems, in general, are covered 24 hrs., 7 days, 3 shifts, using an odd work week schedule. Skill mix includes certified mechanical and electrical technicians, generally performing the following variety of O&M functions:

- o Planned maintenance: cyclic preventive maintenance, including corrosion control, pressure tests, proof tests, and component/system calibrations
- o Unplanned maintenance: resolution of anomalies documented by PR's and DR's, and applicable re-test
- o Modifications: implementation of ground system changes and applicable re-test
- o STS processing: mating, testing, servicing and closeout for launch as dictated by the processing schedule

ELECTRIC/DC POWER/HAZARDOUS GAS DETECTION SYSTEM GH2 LEAK DETECTOR/FIRE DETECTION SYSTEM; 51-L HEADCOUNT = 23

Maintenance, checkout and calibration of all electrical, electronic GSE at LC39A/B including power supplies, back-up batteries, vehicle heaters, pyrotechnics, GH2 and hypergolic detection systems, vehicle microwave systems.

Instrumentation and cabling on all fuel systems, including PRSD, hypergolic, LH2 and LO2 systems.

Supply manpower, test equipment and parts necessary to support PR's, IPR's and TPS's.

Support cargo ops during payload checkout, patch GSE into payload for each mission, provide security monitor for secure patch rooms during DoD missions.

ENVIRONMENTAL CONTROL SYSTEM (ECS); 51-L HEADCOUNT = 32

The ECS system provides air or GN2 to various compartments of the orbiter, PCR white room external/inter tank area, and localized payload air conditioning.

The ECS system provides temperature, humidity, and pressure levels to these various systems.

ECS system technicians routinely have to adjust temperature or flow rates per OTC or engineering.

HYPERGOLIC SYSTEMS; 51-L HEADCOUNT = 42

Maintain ground support equipment, piping, valve complexes and pressure distribution stations for storage and transfer of hypergolic propellants at Pad A/B including removal and replacement of components.

Provides support for servicing the orbiter OMS/RCS systems, orbiter APU system.

POWER REACTANT STORAGE AND DISTRIBUTION/FUEL CELLS (PRSD); 51-L HEADCOUNT = 25

Maintains ground support equipment, liquid oxygen and hydrogen dewars, vacuum jacketed lines and hoses, orbiter mid body umbilical unit, ground cooling units, and pressure distribution and transfer panels on the fixed service structure (FSS) and rotating servicing structure (RSS) for pads.

Also includes removal and replacement of components and servicing orbiter fuel cells.

SWING ARMS/HYDRAULICS FOR SWING ARMS; 51-L HEADCOUNT = 25

Maintain and service all associated systems including pneumatic systems and lines.

Hydraulic charging unit and piping, GOX vent arm, ET vent arm, orbiter access arm, ECS air for ET access and GOX vent arms.

LIQUID HYDROGEN, MAIN PROPULSION SYSTEM (LH2); 51-L HEADCOUNT = 19

Maintain ground support equipment, LH2 storage sphere, flare stacks.

Transfer of LH2 from tankers to storage tank.

Cross country vacuum jacketed lines and hoses.

Pressure distribution and transfer panels of FSS and storage area.

Validate and prep system to load external tank for launch.

LIQUID OXYGEN, MAIN PROPULSION SYSTEM (LO2); 51-L HEADCOUNT = 20

Maintain ground support equipment, LO2 storage sphere.

Transfer of LO2 from tankers to storage tank.

Cross country vacuum jacketed lines and hoses.

Pressure distribution and transfer panels on FSS and storage area.

Validate and prep system to load external tank for launch.

PAYLOAD CHANGEOUT ROOM (PCR) AND PAYLOAD GROUND HANDLING MECHANISM (PGHM); 51-L HEADCOUNT = 26

PCR fixed platforms, extendible platforms, PCR doors, ante room, and air shower maintenance and PCR cleaning prior to payload installation.

PGHM drive mechanism, hydraulic system, J-hook, support beam, LRU extendible platforms, counter balance beams and associated hardware, includes crane and hoist operation.

Processing of vertical payloads both commercial and DoD into the PCR and installation in the orbiter and payload bay, closeout for launch.

LAUNCH COMPLEX SITE MANAGEMENT AND MATRIX SUPPORT COORDINATION; 51-L HEADCOUNT = 28

Direct supervision and management of ground support equipment technicians and coordination of site support requirements to ensure readiness of the site to support the vehicle processing schedule.

This function includes all non-technician staffing, i.e., site manager, shift managers, systems supervisors, site support coordination, secretarial and clerical.

PAD OPERATIONS QUANTIFIERS

- o OM S0009, Launch Pad Validation = 82 technicians
- o OMI S0024, Hypergol Propellant Servicing = 70 technicians
- o PRs, DRs, TPSs, average/month = 120 per pad
- o PMOMIs released into work control system/month = 80 per pad.

11.4.2 MOBILE LAUNCHER PLATFORMS

51-L Headcount = 76

The following describes scope of MLP systems subjected to the usual range of O&M for planned/unplanned/preventive maintenance.

Skill mix includes certified mechanical and electrical technicians, performing maintenance, support calibrations, modifications, validations, and equipment operation in support of preparing the MLP to support the STS launch schedule. Technician distribution to the 3 MLPs for upcoming launch, follow-on launch, and refurb from latest launch averages 50%, 30%, 20% respectively.

TAIL SERVICE MASTS; 51-L HEADCOUNT = 21

Maintenance and operation of the LO2 and LH2 TSM systems (including all pneumatic panels that support the T-0 interface), the bonnet and drop weight system and the T-0 carriers.

The average number of PMOMI's is 9/month and the average number of PR's, DR's, and TPS's is 20/month per mobile launcher.

DC POWER; 51-L HEADCOUNT = 17

Maintain, operate, troubleshoot and repair all DC power supplies and "back-up" battery systems in support of all GSE and orbiter power.

The average number of PMOMI's is 11/month and the average number of PR's, DR's, and TPS's is 15/month.

GROUND HYDRAULICS; 51-L HEADCOUNT = 6

Operation and maintenance of the orbiter/SRB ground hydraulic system in support of vehicle testing and checkout during prelaunch activities.

The average number of PMOMI's is 5/month and the average number of PR's, DR's, and TP's is 11/month.

ORDNANCE; 51-L HEADCOUNT = 3

Installation and removal of ordnance on the T-0 demate devices and the hydrogen preburn ignitors.

Perform maintenance and checkout of all GSE pyrotechnic initiator systems (PIC).

The average number of PMOMI's is 3/month and the average number of PR's, DR's, and TPS's is 5/month.

ENVIRONMENTAL CONTROL SYSTEM (ECS)/PORTABLE PURGE UNIT (PPU); 51-L HEADCOUNT = 4

Maintenance, operation and troubleshooting of the ECS system in support of vehicle operations in the VAB, during transportation of the STS to the launch pad and through STS testing and launch.

The average number of PMOMI's is 9/month and the average number of PR's, DR's, and TPS's is 11/month.

HAZARDOUS GAS DETECTION SYSTEM (HGDS)/GH2 FIRE DETECTION/LEAK DETECTION SYSTEMS; 51-L HEADCOUNT = 12

Operation and maintenance of the HGDS, which requires knowledge of electronics, pneumatic and mechanical systems.

System is operational from validation of the orbiter/launch pad throughout testing, launch and post launch activities.

The average number of PMOMI's is 13/month and the average number of PR's, DR's, and TPS's is 13/month.

MANAGEMENT; 51-L HEADCOUNT = 13

Supervise/manage MLP technicians including training, certification, safety and administration in support of launch vehicle processing flow schedules.

This function includes the managers and supervisors required to direct operations on three (3) MLP's.

11.4.3 FLIGHT SYSTEMS

51-L Headcount = 85

Flight Systems is part of the Pad Operations element and is involved from vehicle stacking at the VAB, transfer to the pad, and the multitude of support resulting in launch. Scope of the support encompasses all flight hardware elements; ET/SRB/ORBITER.

Skill mix includes certified mechanical and electrical technicians performing maintenance, modifications, validations and equipment operations in support of orbiter processing and closeout for launch.

ORBITER FORWARD PERSONNEL; 51-L HEADCOUNT = 23

Prime function: Perform all tasks associated with orbiter vertical processing relative to the forward section.

Perform mating to the external tank, including electrical/mechanical interface connections and support integrated testing to verify readiness for transfer to the launch complex.

Support launch pad validation, terminal countdown demonstration, hypergolic servicing, flight crew ingress, launch countdown.

Install Ordnance

This function requires installation and removal of vertical work platforms, space craft operator functions. Equipment removal/installation, crew compartment preparations and cleaning, maintenance of consec equipment and crew support and closeout for launch.

In addition, an average of 42 PR's, DR's, and TPS's are performed per launch cycle.

ORBITER AFT PERSONNEL; 51-L HEADCOUNT = 25

Prime function: Perform all tasks associated with orbiter aft processing for launch preparations.

Perform mating of the orbiter to the external tank.

Support launch pad validation, terminal countdown demonstration, hypergolic servicing, launch countdown.

Perform ordnance installation, and vehicle closeouts.

Installation/removal of the vertical work platforms, performs connects/disconnects associated with the ground supplied hydraulic system, installs final insulation on the main propulsion system fuel/oxidizer feedlines and the aux power units exhaust ducts.

Performs APU fuel and lube oil servicing, hydraulic accumulator adjustments, stray voltage/resistance checks associated with the demate ordnance, and closes out the aft for launch.

In addition, an average of 112 PR's, DR's, and TPS's are worked per flow.

EXTERNAL TANK (ET) PERSONNEL; 51-L HEADCOUNT = 13

Prime function: Operation and maintenance of GSE associated with external tank processing.

Perform operation and maintenance on GSE including LO2 and LH2 storage areas, swing arms.

Conduct flight element prelaunch checkout.

Load LO2 and LH2 into the external tank for flight.

Post-launch facility and GSE safing

An average of 18 PR's, DR's, and TPS's are processed for each flow.

SOLID ROCKET BOOSTER (SRB) PERSONNEL; 51-L HEADCOUNT = 14

Prime function: Operation and maintenance of support equipment and support integrated testing.

Perform hydraulic connections and disconnections in support of integrated testing, lube oil servicing, nitrogen purge of the aft skirts prior to flight closeout, and solid rocket booster flight closeouts.

Load hydrazine into the "hydraulic power units".

Prepare the thrust vector control system for flight.

An average of 23 PR's, DR's, and TPS's are processed for each flow.

ORBITER MANAGEMENT/SUPERVISION; 51-L HEADCOUNT = 6

Supervise and manage orbiter flight systems technicians in preparing these elements of space shuttle vehicle for launch.

Supervision includes, safety, training, certification, and administration.

This function includes the managers and supervisors required to direct all orbiter operations on a 3 shift, 7 days per week scheduled as required at the pads and VAB.

TANK/SOLID ROCKET BOOSTERS (ET/SRB) MANAGEMENT/SUPERVISION; 51-L HEADCOUNT = 4

Supervise and manage external tank and solid rocket booster flight systems technicians for preparing these elements of space shuttle vehicle for launch.

This includes safety, training, certification, and administration.

This function requires ET support in the VAB and launch pad and SRB support at the launch pad on a 3 shift, 7 days work week schedule as required.

11.4.4 OFFSITE AND CONTINGENCY LANDINGS

51-L Headcount = 93 (see note below)

NOTE: The above headcount is extrapolated from the SPC organization structure existing 6/87; having a headcount of 104. It is recognized the element was not yet organized to this level during 51-L preps. Attempts to precisely reconstruct headcount for 51-L have been unsuccessful. This is a portion of the accurately reported Operations headcount of 1025. Any reduction or adjustment to headcount for this function should be distributed within Operations.

KENNEDY SPACE CENTER (KSC); 51-L HEADCOUNT = 35

- o Develop and maintain all documentation associated with offsite landing sites to include but not limited to:
 - New site survey reports
 - New site implementation plans
 - Modification implementation plans
 - Offsite operations plans for each site
 - Convoy operations plans
 - Operations schedules
 - Feasibility/ROM studies
 - Program requirements directives
 - Test plans for one time operations of new equipment
 - Applicable operations and maintenance instructions
 - Offsite personnel requirements listings and travel/accommodations coordination
 - Contract change order analysis and negotiations
 - Personnel requirements studies
- o Maintain and control orbiter GSE required for:
 - Landing
 - Orbiter turnaround
 - Ferry operations
 - Orbiter tow to OPF
 - Convoy Operations
 - Orbiter mate to SCA
 - Demate orbiter from SCA
 - Orbiter move operations
- o Operational responsibilities:
 - Return to launch site (RTLS) convoy readiness
 - Crew egress/rescue operations
 - Orbiter/SCA demate
 - Orbiter tow to OPF
 - Orbiter move operations
 - Conduct unique operations to test new equipment/procedures

DRYDEN FLIGHT RESEARCH FACILITY (DFRF); 51-L HEADCOUNT = 42

- o Maintenance and validation of all onsite GSE and DFRF facilities and equipment required to support:
 - Landing
 - Orbiter jacking
 - Orbiter/SCA mate
 - Convoy operations
 - Orbiter preps for ferry

- o Operational responsibilities:
 - Preparations for supporting potential early or planned landing
 - Convoy operations to support orbiter safing, crew egress preps to tow and tow to MDD
 - Orbiter jacking in MDD
 - Orbiter preparations for mate to SCA
 - Orbiter/SCA mate and preps for ferry to KSC
- o Preparations for landing are normally accomplished prior to launch by the permanent DFRF crew (6) supplemented by KSC personnel working a 5 or 6 day/1 shift work week.
- o Subsequent to landing, personnel on site for preps and additional personnel from KSC provide 3 shift per day coverage to expedite orbiter turnaround and ferry to KSC.

WHITE SANDS SPACE HARBOR (WSSH); 51-L HEADCOUNT = 1

- o Pre-launch requirements
 - Ensure all preparations are made to support a potential EOM/AOA landing
 - Provide personnel to control/perform immediate post landing operations
- o Potential post landing requirements
 - Provide point of contact for resource deployment to WSSH in case of an actual landing
 - Conduct turnaround operations as at DFRF in case of actual landing
- o Normally requires KSC/DFRF convoy personnel on site for approximately 10 days each mission o Actual landing would require personnel 3 shifts/day until turnaround completed.

TRANSOCEANIC ABORT LANDING SITES (TAL); 51-L HEADCOUNT = 15

- o Pre-launch requirements
 - Ensure all required equipment and personnel are onsite and ready to support a potential abort landing
 - Serve as senior Lockheed representative onsite responsible for operational control of resources
- o Post-launch - no abort
 - Control all phases of deactivation of site
 - Ensure all equipment is secured and/or stored for subsequent missions
 - Ensure all personnel and special equipment are deployed to KSC in a timely manner
- o Abort landing requirements
 - Conduct post landing operations (orbiter safing, crew egress, tow to deservicing/mate area)
 - Coordinate orbiter turnaround requirements (equipment/personnel)
 - Conduct orbiter turnaround, mate to SCA, and ferry preps.
- o Requirement is for 3 of 4 TAL sites to be manned and operational prior to each launch. Sites to be manned depend on launch azimuth. Personnel and some equipment are deployed to designated TAL sited for each launch.

- o Equipment and systems required vary by site. Equipment normally kept in storage must be removed from storage, installed and validated prior to launch, then removed and stored after abort landing opportunity has passed.
- o Sufficient personnel and equipment will be onsite to conduct immediate post landing operations. A large number of additional personnel along with extensive equipment would have to be transported to the site to support a turnaround operation.

SAMPLE IMPACT OF OFFSITE LANDING

Challenger Mission 51-F was launched from KSC July 29, 1985 and landed, as scheduled, at EAFB August 6, 1985.

The following offsite landing teams were identified and formed to support this mission:

TEAM A: PRE-OPERATIONS TEAM

49 people required at DFRF for scheduled landing/turnaround operations preps;
32 KSC, 11 DFRF, 6 VLS; travel started 7/30/85

TEAM B: DFRF CONVOY AND TURNAROUND TEAM

168 people required at DFRF to provide convoy ops, orbiter preps and mate to SCA for ferry to KSC; 118 KSC, 46 VLS, 4 cargo removal only; travel started 8/4/85.

TEAM C: TAL/CLS RAPID RESPONSE TEAM

25 people from DFRF and KSC to TAL/CLS landing site + 8 hrs.

TEAM D: DFRF EQPT. PREP./SHIP TO TAL/CLS RR TEAM

35 people required to deploy to DFRF to prep/ship eqpt. to TAL/CLS

TEAM E: PRE-LAUNCH TAL/CLS TEAM

14 people required at TAL/CLS prior to launch for landing aids, MSBLS and other preps; travel started 7/30/85.

TEAM F; OVERSEAS TAL/CLS TURNAROUND TEAM

255 people required to deploy to TAL/CLS for orbiter preps and mate to SCA for ferry to KSC.

Personnel lists included 440 names of active team members for this mission (106 served on 2 teams):

344 LSOC/KSC; 53 VLS; 22 EG&G/KSC; 8 DFRF; 12 Rocketdyne; 1 WTI

231 people actually deployed to support the mission:

- o Team A
- o Team B
- o Team E

The operation was controlled/documentated by 14 major OMIs:

- A. V1038 - MPS/SSME Post Landing Operations
- B. V1049 - APU Safing
- C. V1067 - Orbiter PRSD Cryo Drain
- D. V1070 - OMS/RCS Deservicing at Secondary Landing Site
- E. V1073 - ECLSS System Preps for Ferry
- F. V1101 - Orbiter Tailcone Assembly

- G. V1130 - Orbiter Flight Tape Recorder Dump to GSE during Post Flight Operations
H. V1133- Orbiter Hydraulic Fluid Contamination Safing and Cleanup
I. V5017 - Crew System Destowage
J. V5021 - Tailcone Installation
K. V5022 - Orbiter Mate to SCA
L. V5032 - Pyro Removal and System Safety.
M. V9003 - Orbiter Power-Up/Down DFRF
N. V9005 - HYD STD Power-Up/Down DFRF

The 72 hour/11 Day Operations Schedule listed 138 major OMI work sequences and covered a period of 91 hours (nearly 4 days) to reach "ready for ferry".

<u>FLUID</u>	<u>SPECIFICATION</u>	<u>REQUIREMENTS/ LANDINGS</u>	<u>ACTIVITY SUPPORTED</u>
LN ₂	MIL-P-27401	8,500 - GAL	GN ₂ , LAIR, WILTECH
LO ₂	MIL-P-25508	1,000 - GAL	LAIR MIX
GH ₂	MIL-P-27407	40,000 - SCF	PRESSURANT/PURGE/WILTECH
GN ₂ ^e	MIL-P-27401	200,000 - SCF	PRESSURANT/PURGE/WILTECH
LAIR	JSC-SD-A-0019	2,000 - GAL	LIFE SUPPORT
BAIR	JSC-SD-A-0019	10,000 - SCF	LIFE SUPPORT/WILTECH
DMH ₂ O	JSC-SPEC-C-20C	5,000 - GAL	WILTECH/FLUSH
25% NaOH	KSC-TG-PID-08	650 - GAL	HTV SCUBBER FLUID
IPA	TT-I-735A	165 - GAL	WILTECH/FLUSHING
SOLVENT 113	MIL-C-81302B	440 - GAL	WILTECH/FLUSHING
HYD. FLUID	MIL-H-5606C	16 - GAL	SCA SERVICING
HYD. FLUID	MIL-H-83282A	76 - GAL	ORBITER SERVICING
COOLANT 14	BB-F-1421A	350 - GAL	GSE SERVICING
REFRIGERANT 12	BB-F-1421A	100 - LBS	GSE SERVICING
REFRIGERANT 22	BB-F-1421A	10 - LBS	GSE SERVICING
GH ₂	MIL-P-27201B	1,200 - SCF	WILTECH OPS
HNO ₃	FED-SPEC-O-N-350	52 - GAL	WILTECH OPS
H ₃ PO ₄	FED-SPEC-O-0-670	55 - GAL	WILTECH OPS
CAUSTIC SODA		55 - GAL	WILTECH OPS

POSSIBLE FLUIDS WASTES - DFRF

<u>FLUID</u>	<u>QUANTITY (GAL)</u>	<u>TYPE CONTAINER</u>	<u>QUANTITY</u>
MMH	420	55-GAL DRUMS, DOT 5C 304L	8
N ₂ H ₄	65	55-GAL DRUMS, DOT 5C 304L	2
N ₂ O ₄	420	2,000 # CAP H.P. CONTAINERS, DOT 106A500X	3
HTV (MMH)	750	55-GAL DRUMS, DOT 5C 304L	14
HTV (N ₂ O ₄)	650	55-GAL DRUMS, DOT 6D/25	12
Freon 113	250	55-GAL DRUMS, DOT 17E	5
IPA	1,000	55-GAL DRUMS, DOT 17E	19
H ₂ O	150	55-GAL DRUMS, DOT 17E	3
Hydraulic Fluid (5606C & 83282A)	92	55-GAL DRUMS, DOT 17E	3

WASTE CONTAINERS

TOTALS	DRUM, 5C 304L	- 24
	DRUM, 6D 2S	- 12
	DRUM, 17E	- 30
	H.P. CONTAINERS, 106A500X	- 3

12.0 MORTON THIOKOL (MTI)

ET AND SRB PROCESSING; 51-L Headcount = 341

12.1 **RESPONSIBILITY** - Morton Thiokol, Inc. is a subcontractor to Lockheed on the SPC and provides the following solid rocket booster (SRB) and external tank (ET) processing functions:

- o SRB processing
 - Receive segments from MTI Wasatch/MSFC
 - Receive aft skirt, forward assembly and ancillary hardware from USBI/MSFC
 - Offload from railcar
 - Checkout and prepare for stack
 - Mate aft booster with aft skirt and prepare for stack
 - Stack and close-out for launch
 - Recover flown boosters from ocean after launch
 - Disassemble boosters and return components to manufacturers for refurbishment
- o ET operations
 - Receive ET from Martin/MSFC, Michoud
 - Offload from barge
 - Checkout and complete assembly
 - Mate to SRB
 - Final preps for launch

Additional function details are presented in the subsequent section entitled Work Volume Indicators.

12.2 51-L HEADCOUNT SUMMARY

OVERALL HEADCOUNT

o Administration	6
o ET/SRB processing	204
o SRB retrieval/disassembly	88
o Process support	43
Total:	<u>341</u>

MORTON THIOKOL ELEMENTS HEADCOUNT

o Director VAB Operations/admin. support	6
o SRB/ET Processing (204)	
- Offload ET from barge/preflight check	32
- Offload SRM segments from railcars and prestack assembly	46*
- SRB stack	41*
- ET/SRB mate and closeout	40
- GSE maintenance	15
- MLP holddown posts refurb/pad support	30
o SRB Recovery and Disassembly	88
o Process Support (43)	
- GSE engineering	31
- Site management	8
- Enhancement studies	4
Total:	<u>341</u>

* 17 of these total cross-utilized between prestack assembly and SRB stack.
Note: Overtime for SRB/ET processing averaged 21% during Nov/Dec 1985. SRB recovery and disassembly overtime averaged 30%. Overtime for the entire MTI group averaged 20.8%.

12.3 WORK VOLUME INDICATORS

MANAGEMENT/ADMINISTRATION; 51-L HEADCOUNT = 6

Manpower driven by requirements levied by launch processing manifest. All MTI/SPC contract functions are managed by this department, including budget, financial management and human resources. Area of responsibility is the direction and administration of the MTI VAB operations organization which includes the RPSF and Hangar AF retrieval and disassembly operations.

Certain activities are common to all of the following MTI operations elements and are included in those descriptions by this reference. They include:

- o Skill mix includes electrical and mechanical techs, work station support coordinators, lift coordinators and supervision.
- o Maintain inventory of ET/SRB consumables and non-flight materials.
- o Kit parts and materials and deliver to work stations.
- o Provide tool crib support to ET/SRB processing operations.
- o Supply manpower, equipment, materials and parts to support PRs, IPRs, DRs, and TPSs.
- o Provide supervision management and clerical support for ET processing.

12.3.1 VAB/RPSF OPERATIONS

OFFLOAD ET FROM BARGE AND PREFLIGHT CHECKOUT; 51-L HEADCOUNT = 32

- o Offload ET from barge, transport to VAB and position in checkout cell.
- o Perform KSC planned work, including ordnance installation and TPS closeout, as identified in OMRS and ET turnover documents.
- o Conduct ET system tests.
- o Install, validate and test ET modifications and emergency field engineering changes.
- o Transfer ET to storage cell at conclusion of checkout operations.
- o ET processing involves 85 major (a minimum of 6 in parallel) operations per tank conducted on 10 high bay levels).
- o Operations are conducted on a 2 shift, 5 day basis.
- o Tests are conducted on 5 flight systems.
- o 790 components are handled and installed in this function.

OFFLOAD SRM SEGMENTS FROM RAILCARS AND PRESTACK ASSY.; 51-L HEADCOUNT = 46

- o Offload SRM segments from railcars.
- o Support receiving inspection of SRMs.
- o Position SRM segments on pallets and place in surge.
- o Receive aft skirts and install in buildup stands.
- o Mate aft SRM segments to aft skirts.
- o Buildup and perform electrical checkout of aft booster assemblies (includes installation of stiffener rings, ETA rings, systems tunnels, IEAS, struts, electrical cables, thermal curtains, and rain curtains).
- o Offload nozzle exit cone extensions from railcars.
- o Install nozzle exit cone extension.
- o Move empty SRM pallets from parksite and VAB to RPSF.
- o Install, validate and test SRM/SRB modifications and emergency field engineering changes.
- o RPSF processing involves 88 major (a maximum of 6 in parallel) operations per SRB conducted on eight levels and in five facilities.
- o Operations are conducted on a 3 shift, 5 day basis.
- o Skill mix includes electrical and mechanical techs, work station support coordinators, lift coordinators and supervision.
- o 5000 components are handled and installed in this function.

SRB STACKING; 51-L HEADCOUNT = 41

- o Receive and inspect forward assemblies.
- o Stack aft booster assemblies, SRM segments and forward assemblies on MLP.
- o Secure aft booster assemblies to holddown posts and tension.
- o Pin, leak check and band SRB field joints.
- o Perform field joint closeout.
- o Install targets and support optical alignment of stacked SRBs.
- o Perform contingency destack of SRBs.
- o Install, validate and test SRB modifications and emergency field engineering changes.
- o Three crews are required per shift to support three parallel operations in the VAB transfer aisle and on six levels in the high bay. 53 major operations are conducted per SRB.
- o Operations are conducted on a 3 shift, 5 day basis.

ET/SRB MATE AND CLOSEOUT; 51-L HEADCOUNT = 40

- o Remove ET from storage cell and transfer to integration cell.
- o Mate ET to SRBs.
- o Perform ET/SRB final assembly, electrical checkout and closeouts for flight.
- o Support mating operation of orbiter to ET.
- o Support shuttle interface test.
- o Support pad operation.
- o ET/SRB mate and closeout involves 144 major (a minimum of 6 in parallel) operations per flight set conducted on 11 high bay levels.
- o Operations are conducted on a 3 shift, 5 day basis.
- o 6,660 components are handled and installed in this function.

GSE MAINTENANCE; 51-L HEADCOUNT = 15

- o Maintain ET and SRB GSE.
- o Modify ET and SRB GSE.
- o Control GSE, tools and sensitive items.
- o GSE maintenance is performed in 3 separate facilities and requires extensive contact and coordination with numerous agencies (i.e., LES shop, GTSI, Wiltech, logistics, supply, Bionetics, etc.)
- o Operations are conducted on a 2 shift, 5 day basis.
- o 970 GSE items are maintained in this function.

MLP HOLDDOWN POST REFURBISHMENT AND PAD SUPPORT: 51-L HEADCOUNT = 30

- o Refurbish MLP holddown posts.
- o Perform MLP holddown post alignment (once per flow).
- o Perform final SRB ordnance counnections.
- o Closeout SRB holddown posts, forward and aft IEAs, range safety systems, igniters and forward and aft skirts for flight.
- o Processing involves 61 major operations per flow conducted on 3 mobile launchers.
- o Operations are conducted on a 3 shift, 5 day basis.
- o Peak manpower requirements which occur during ordnance operations are provided by borrowing personnel from the SRB stacking crews.
- o 500 components are handled and installed in this function.

12.3.2 HANGAR AF, CCAFS OPERATIONS

RETRIEVAL AND DISASSEMBLY OF SRBs; 51-L HEADCOUNT = 88

- o Operate the retrieval vessels.**
- o Perform retrieval vessel mods and maintenance.**
- o Perform retrieval GSE mods and maintenance.**
- o Perform diving equipment mods and maintenance.**
- o Provide disassembly support.**
- o Perform SRB disassembly.**
- o Perform facilities and GSE O&M.**
- o Perform facilities and equipment modifications.**
- o Provide retrieval support.**
- o Perform sustaining engineering for retrieval vessels and their associated systems.**
- o Perform sustaining engineering for systems at hangar AF.**
- o Manpower is cross utilized between retrieval, disassembly and assembly operations.**
- o Marine operations, equipment O&M are per the American Bureau of Ships Standards and U.S. Coast Guard regulations.**
- o Each ship crew is manned for 24 hour a day operation.**
- o Dive team size is based on 10 minute bottom line.**
- o Support retrieval/disassembly operations.**
- o Support post-flight evaluation of flown hardware (post-flight inspections).**
- o Provide retrieval diving team members.**
- o Perform systems/GSL O&M and modifications between STS missions.**
- o Disassembly processing includes breakdown of SRBs into 2000 sub-assemblies/components and shipment to element contractors/vendors including SRM segment loading on railcars.**

12.3.3 SRB/ET PROCESS SUPPORT

GSE ENGINEERING; 51-L HEADCOUNT = 31

- o Maintain 968 items of GSE ET & SRB, all require periodic maintenance.
- o Issue all SRB and ET GSE paper, disposition MRs and DRs.
- o MICR preparation and file maintenance (OM, OMI, SPI, DWGS, specs, etc.)

SITE MANAGEMENT; 51-L HEADCOUNT = 8

- o Coordinate needs of all VAB tenants, prepare and review ESRs, chair ESR miniboard.
- o Participate in IERB.
- o Safety Committee coordination.

ENHANCEMENT STUDIES; 51-L HEADCOUNT = 4

- o Special studies and analyses
- o Perform flow analyses and computer data
- o Perform internal audits

13.0 BUSINESS MANAGEMENT

Contracts, Finance, Personnel, etc.; 51-L Headcount = 331

13.1 RESPONSIBILITY - Manage and direct the SPC; including the full spectrum of resources management including legal, contractual, finance, personnel, payroll, benefits, labor relations, security, etc. as is common to any major American aerospace firm conducting business with the U.S. Government in today's technical and business environment.

13.2 51-L HEADCOUNT SUMMARY

OVERALL HEADCOUNT

Program Manager and Central Staff	39
Human Resources	72
Business Management	4
Accounting & Financial Controls	47
Program Controls	110
Business Systems & Office Systems	52
Contract Administration	7
Total:	331

Note: Overtime data not included in references.

BUSINESS MANAGEMENT ELEMENTS HEADCOUNT

o Program Manager & Central Staff (39)	
- Program Manager	13
- Public Affairs	5
- Company Counsel	2
- Admin. & Management Planning	19
o Human Resources (72)	
- Human Resources	8
- Employment	9
- Management Compensation	13
- Security	22
- Salaried Personnel	7
- Human Resources Development	7
- Equal Employment Opportunity	3
- Labor Relations	3
o Business Management (4)	
- Business Management	3
- New Business and Acquisition	1
o Accounting and Financial Controls (47)	
- Accounting & Financial Controls	3
- Chief Accountant	31
- Financial Controls	11
- Financial Planning	2

o Program Controls (110)	
- Program Control	8
. Program Budget Planning and Control	19
. Program Management Systems	18
. Proposal Management	8
- Configuration Management	
. Ground Requirements Planning and Control	33
. Flight Requirements Planning & Control	20
. Field Office	4
o Business Systems and Office Systems (52)	
- LMIS business computer operations	9
- LMIS business systems development & maintenance	18
- KSC office systems and services	25
o Contract Administration	<u>7</u>
Total:	331

Note: Overtime data not included in references.

13.3 WORK VOLUME INDICATORS - This section presents a brief summary of available quantified work drivers. Business management functional elements are somewhat generic and functional details considered beyond scope of this document are not addressed.

ADMINISTRATION AND MANGEMENT PLANNING - Responsible for the development, coordination and update of standard practice instructions (SPIs). Approximately 400 SPIs have been released to date (6/87).

Responsible for the development, coordination and update of management directives (MDs) and mangement procedures (MPs). Approximately 161 MDs and MPs have been released to date (6/87).

LABOR RELATIONS - Administers company labor relations program between company and three union groups working SPC; IAM, IBEW, and POID. This includes over 1000 SPC employees.

CHIEF ACCOUNTANT - Handles an average of 2500 invoices monthly. Handles an average of 250 travel expense reports monthly.

FINANCIAL CONTROLS - Handles an average of 550 labor audits monthly.

PROGRAM MANAGEMENT SYSTEMS - 600 account orders and work packages monthly. Level II/IV CCB activity 160/month. 120 management systems procedures review/update per month. 200 charts/month (program status, mod/contract change status, functional organization performance. 60 overtime analysis and status reviews per month.

Internal/external report generation, control and validation:

- o 44 monthly and 20 quarterly 533s
- o 8 weekly and 35 monthly manpower reports
- o 200 charts per month (program status, mod/contract change status, functional organization performance)
- o 150 unique performance and management reports per month.
- o 60 Ad Hoc reporting and analysis exercises per month.
- o Safety, reliability, maintainability and quality assurance.

GROUND REQUIREMENTS PLANNING AND CONTROL

- o Tracks and statuses 106 NASA/SPC STS-26R category 1 requirements to include 35 category 2 highly desirable requirements. Provides change status for publications.
- o Communication and design engineering. Handles change traffic with monthly averages as follows:
 - Change requirements (ESRs, CCBDs, CRs) 317
 - Assessment/implementation plan 180
 - Change Correspondence 400
- o Change management - handles change traffic with monthly averages as follows:
 - New requirements 317
 - Change status 600
 - Data entry transactions 930
 - Change status (via phone) 965

Open requirements maintenance (EST) CM status and
account from receipt to closure (INC)

Category 1	408
Category 2S	241
Category 2	509

CONFIGURATION ACCOUNTING AND VERIFICATION

- o Ground Systems: Approximately 2091 pressure vessels statused under P... cert program.
- o All Sites: Process approx. 50 Test Preparation Sheets (TPS)/month.
- o All Flight Hardware: Process approx. 80 TPS's/month; approx. SEPAR 140 transmittals/month (from 3 to 200 pages each); approx. 54 RI LSS Configuration Discrepancy Reports (CDR)/month; approx. 115 Orbiter Software Change Requests (OSCR)/Data Change Requests (DCR) per month.

LMS BUSINESS COMPUTER OPERATIONS

- o Production Control: Schedule, stage, and review 757 production jobs/month for 3 business systems and control distribution of 5878 reports generated monthly.
- o System Maintenance: Technical maintenance of 2 local and 1 remote HP 3000.
- o Operations: 7-day/3-shift operation in support of 140 on-line users, development programmers, and batch production schedules. Distribute 7000 reports/month. Operate HP 3000 computer systems and laser printers.

LMS BUSINESS SYSTEMS DEVELOPMENT AND MAINTENANCE

- o 2555 software service requests processed to date (6/87).
- o 1,200,000 lines of code. Industry standards: 32 programmers maintenance only (no development, no management).

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KSC OFFICE SYSTEMS AND SERVICES

- o 934 graphic displays per month
- o 320,000 pieces of reproduction per month
- o 10,664 pieces of mail per month
- o 3 contract deliverables per year (records management)
- o Forms per month:

Filled requests	61
New or revised	11
KSC	22
- o Word processing per month:

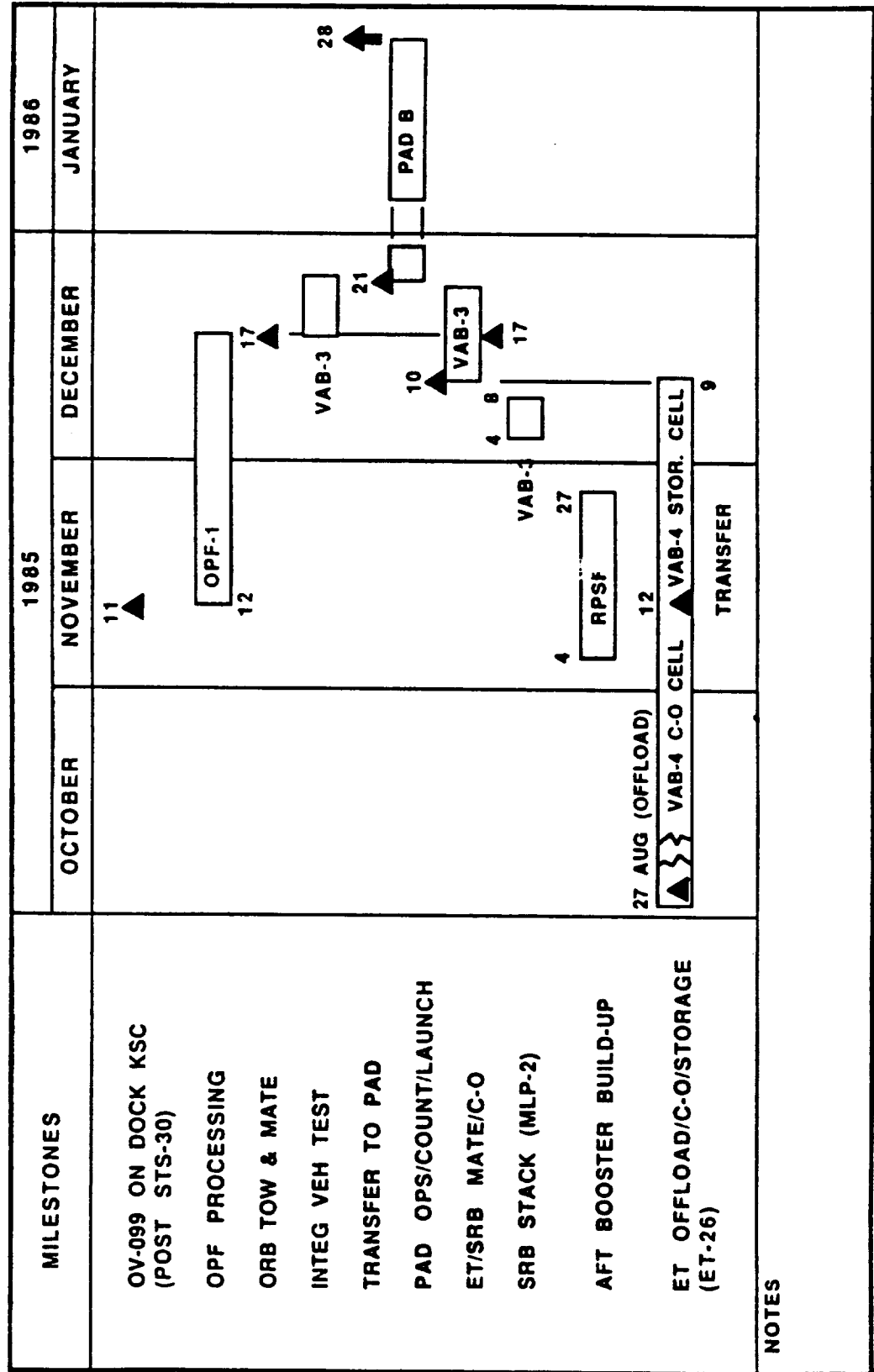
Requests	75
New or revised	612
Processed	734

APPENDIX A - 51-L PROCESSING TIMELINES

This appendix consists of barcharts provided by LSOC personnel engaged in the KSC Liquid Rocket Booster Study. They are included herein as a supplement to the 51-L work volume indicators. The charts show information on overall process flow and lower-level timeline breakdowns such as OPF, SRB, and ET processing.

**STS MISSION
51-L REPORT**

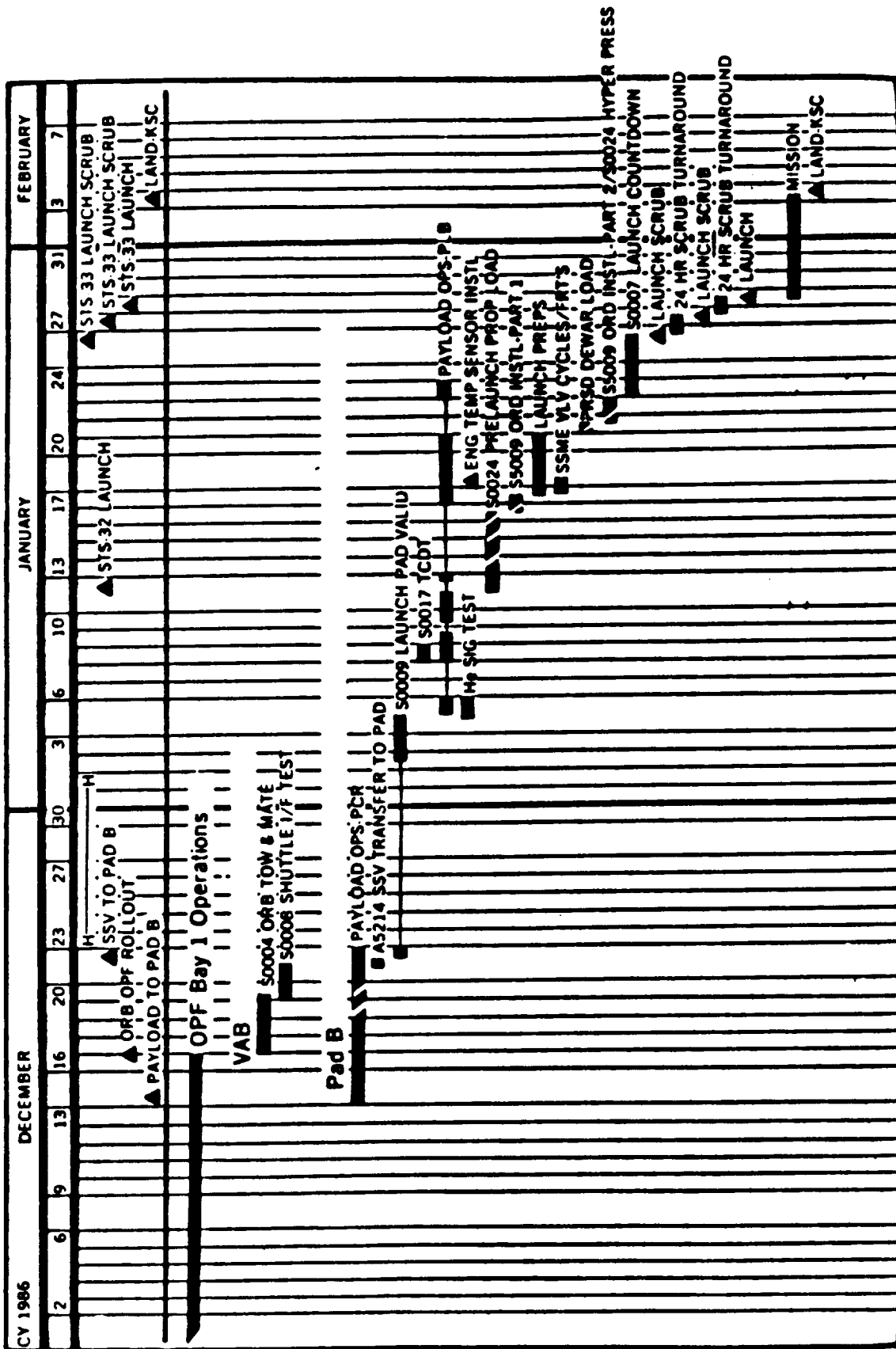
PROCESS FLOW SUMMARY



51-L(STS-33/OV-99)Integrated Operations Assessment Summary

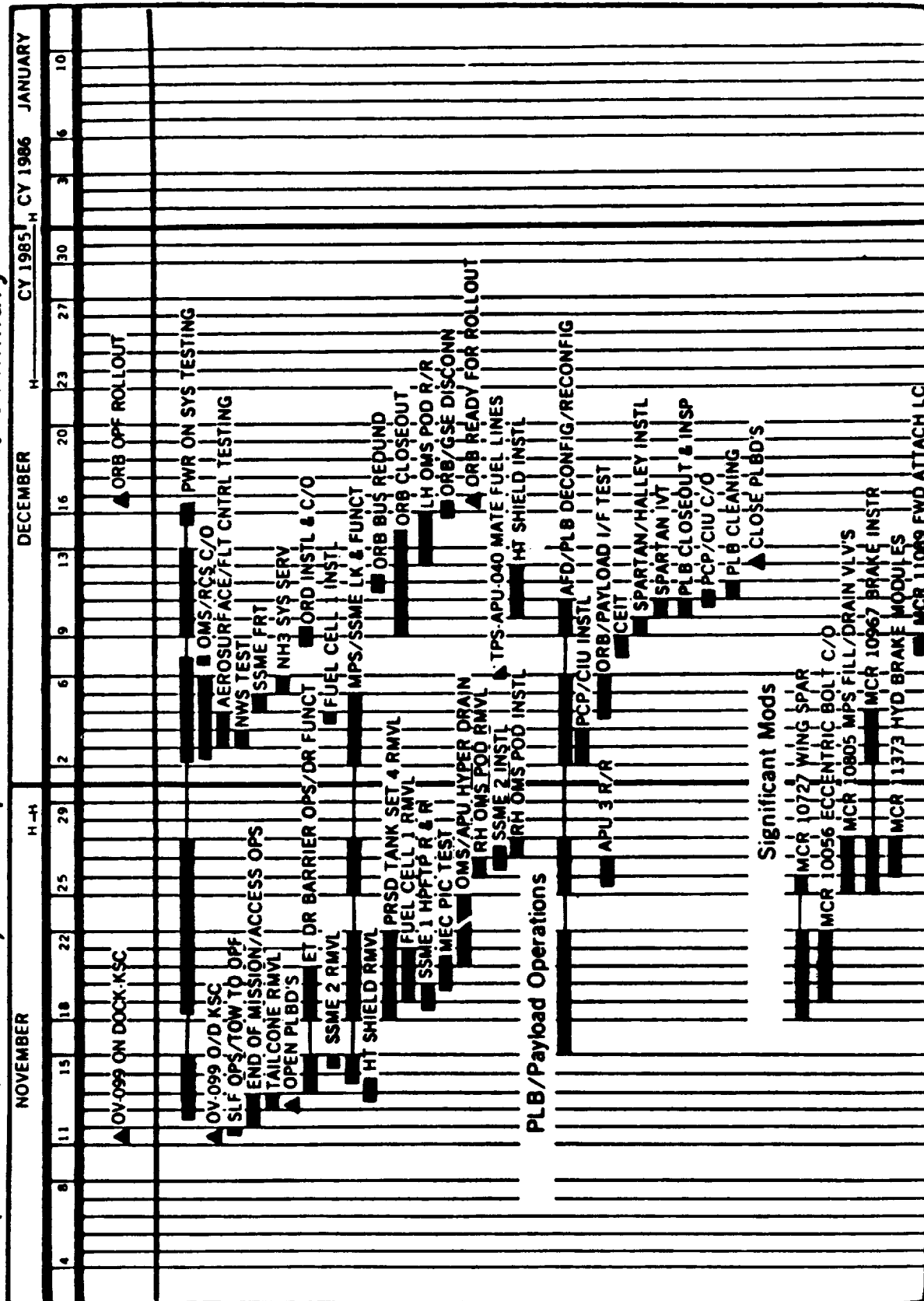
LSOC INTG
27 January 1986

Payload SPARTAN HALLEY (IMPRESS) / TDORS B (HUS 3)

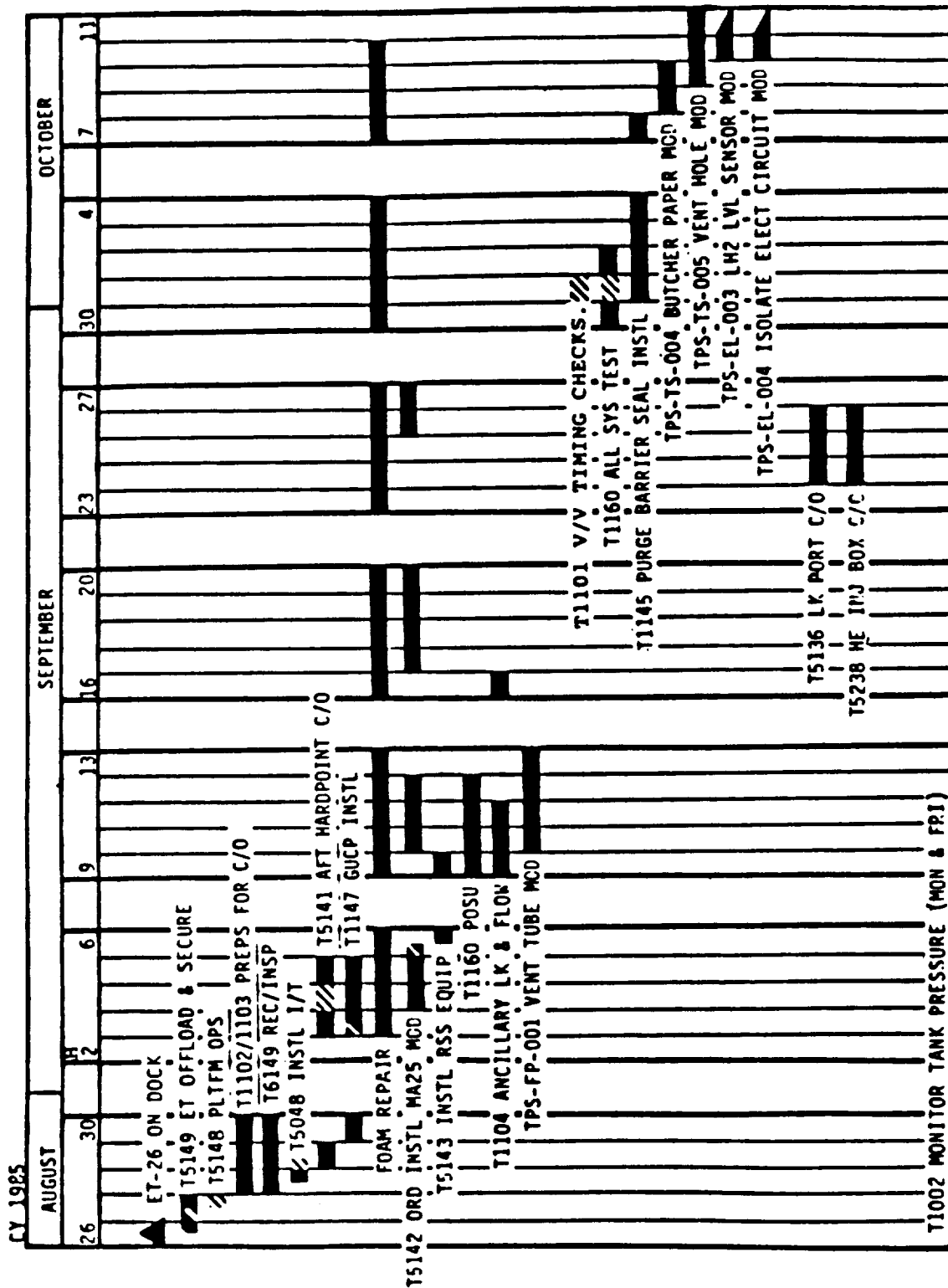


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51-L(STS-33/OV-099)OPF Operations Assessment Summary

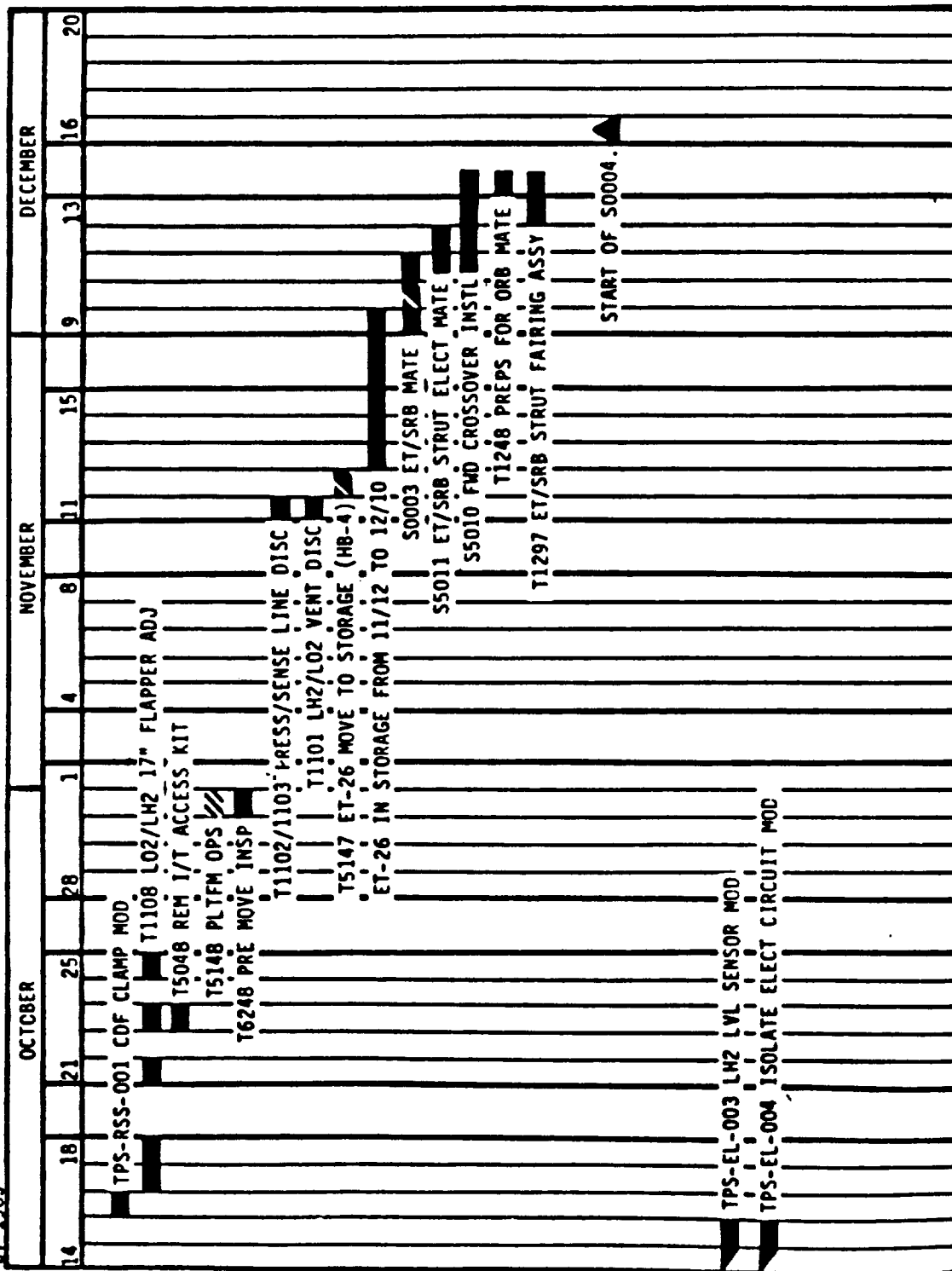


51-L (STS-33) ET OPERATIONS ASSESSMENT SUMMARY

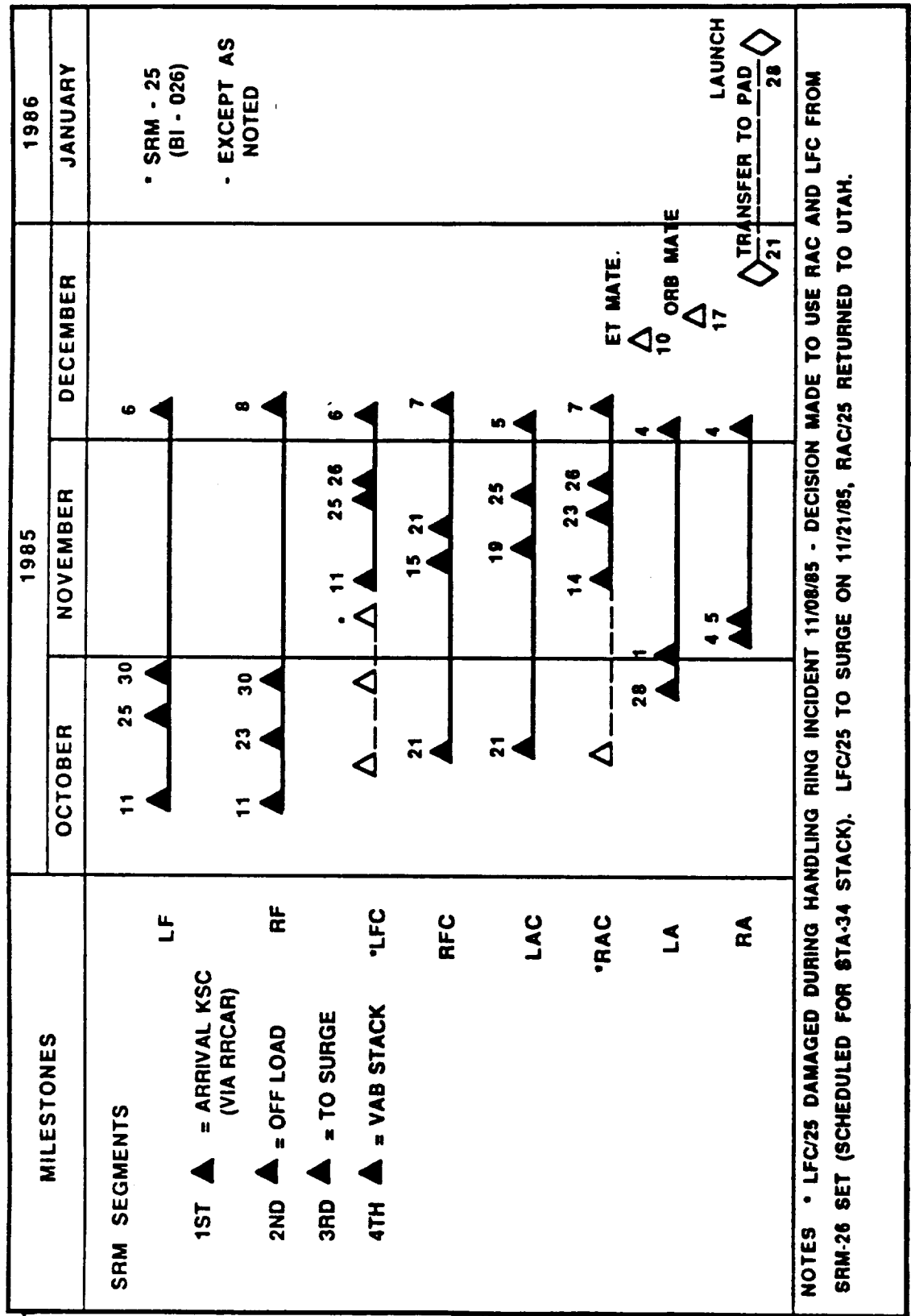


51-L (STS-33) ET OPERATIONS ASSESSMENT SUMMARY

CY 1985



SRM/SRB PROCESSING



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APPENDIX B - 51-L MANPOWER SUMMARY

This appendix consists of LSOC charts, of SPC 51-L headcount, 51-L mission-unique manhours (with overtime), and overall SPC overtime percentages during Oct 85 - Jan 86, a critical period during which four orbiters and related flight components were in process at KSC. The manpower breakdown of this appendix differs somewhat from the main report data in method of organizational dissection; providing another perspective of shuttle ground processing work load in manhours (both straight and overtime).

The 51-L headcount of 6110, used as baseline in this report agrees within 2% of the 6244 of this appendix (6388 sans Rocketdyne, RIC, and Pan Am).

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51-L REPORT

CURRENT SPC MANPOWER*

<u>KSC OPERATIONS</u>	<u>LSOC</u>	<u>SUBCONTRACTOR</u>
OPF	628	MTI 413
PAD	425	ROCKETDYNE 62
LCC	77	RIC(TILE) 59
PP&C	286	PAN AM 23
OTHER(STAFF)	12	

557

SUPPORT OPERATIONS	1186	GRUMMAN	748
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PROCESS ENGINEERING	873	TOTAL =	1305
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PAYLOAD INTEGRATION

SAFETY, RELIABILITY &

QUALITY ASSURANCE

LOGISTICS

ADMIN & OTHER

LSOC TOTAL =

SUBCONTRACT TOTAL =

SPC TOTAL =

*REF LSOC I.1 REPORT
WEEK ENDING 1-31-86

STS MISSION
51-L REPORT

SPC MISSION-UNIQUE MANPOWER
FY-86 - WBS 1.1 (SHUTTLE PROCESSING - STS-33 ONLY)

<u>KSC OPERATIONS</u>	<u>ST</u>	<u>OT</u>	<u>TOTAL</u>	<u>% OT</u>
OPF	36529	8012	44541	21.9
PAD	30860	14031	44891	45.5
LCC	5300	1244	6544	23.5
PP&C	—	(NO MISSION-UNIQUE CHARGES)		—
MTI (EST)	31254	7296	38550	23.3
RDYN	4162	909	5071	21.8
RIC (TILE B.S.)	—	(DATA NOT AVAILABLE)		—
PROCESS ENGINEERING	34600	8431	43031	24.4
PAYLOAD INTEG	7242	1115	8357	15.4
SR&QA	17159	4878	22037	28.4
OTHER (LSOC)	518	202	720	—
TOTAL LSOC	132,208	37,913	170,121	28.7
TOTAL SUBCONTRACTORS	35,416	8,205	43,621	23.2
GRAND TOTAL	167,624	46,118	213,742	27.5

**STS MISSION
51-L REPORT**

OVERTIME PERCENT BY ORGANIZATION

ORGANIZATION	1985			1986
	OCTOBER	NOVEMBER	DECEMBER	JANUARY
PAYLOAD INTEG	14.36	10.98	8.77	10.88
PROC ENGR	13.78	15.09	10.33	13.70
PP&C	15.61	16.83	11.75	10.40
OPF	23.10	23.81	13.40	14.36
VAB (JMT)	13.31	20.78	13.31	13.63
LCC	9.23	11.21	11.50	18.46
PAD	18.08	25.35	27.66	24.81
INTEG GRN OPS (GRUMMAN)	3.26	4.09	2.82	7.95
SUPPORT ENGR	5.10	3.88	3.90	4.12
FAC O&M	21.27	25.73	24.45	22.27
COMM	10.48	6.87	7.01	14.26
TEST SUP MGMT	4.69	5.36	9.09	8.70
LOGISTICS	9.03	9.48	10.71	13.30
R&QA	16.61	23.32	15.99	17.46
SAFETY	13.83	13.27	13.27	18.03
• LOCKHEED ONLY	14.82	16.41	13.48	14.86
• SPC - ALL	13.33	15.19	12.17	13.90
NOTES				



Report Documentation Page

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